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JOURNAL
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VOL. 26 OCTOBER, 1933 No. 5

Proceedings of the Eighth Annual Meeting of the Cotton States Branch American Association of Economic Entomologists

The eighth annual meeting of the Cotton States Branch was held at New Orleans, Louisiana, on February 2 and 3, 1933. It proved to be one of the best meetings of the Branch and was well attended considering the fact that practically all attendants had to make the trip at personal expense. Two sessions were required for the presentation of the rather long program which dealt with insects attacking cotton, peaches, sugar cane, and other crops grown in the southern region. Considerable informal discussion followed the presentation of the twenty-two papers which were classified as follows:

Insects Injurious to Cotton	10	Insects Injurious to Roses	1
Insects Injurious to Peaches	3	Insects Injurious to Truck Crops	1
Insects Injurious to Sugarcane	3	Miscellaneous Injurious Insects	1
Insects Injurious to Citrus	1	Bees	1
Insects Injurious to Corn	1		

The meeting was attended by the President of the American Association of Economic Entomologists for 1933, Dr. W. E. Hinds, of Baton Rouge, La. In response to the introduction given by Dr. J. W. Folsom, president of the Cotton States Entomologists, and invitation for remarks, Dr. Hinds expressed his appreciation of the honor of representing the parent association at this gathering. He described the meetings of the Entomological Society of Paris, celebrating its 100th anniversary, and the sessions of the Fifth International Congress of Entomology held in Paris July 16–23, 1932, to both of which Dr. Hinds was one of the delegates from the American Association of Economic Entomologists. The Anniversary meeting of the Entomological Society of Paris, which is the oldest entomological society in the world, was honored by the attendance of the President of France with members of his official staff. After welcoming addresses and responses and the address of the president of the Entomological Society, the foreign delegates and representatives

were introduced individually. Most of these delegates appeared in academic dress or in the regalia of the societies which they represented officially. Many of them presented elaborately inscribed or bound expressions of felicitation which were presented to the Entomological Society of Paris for their Archives. A very hearty welcome was given to the representatives from Germany and Austria, as well as those from all other countries. The meeting was characterized by an unusual degree of dignity and grace, with the spirit of friendship and cooperative good will throughout.

The meeting of the International Congress of Entomology consisted of general sessions in the forenoon with sectional group meetings in the afternoon. Most of the papers were presented in French or German and but few were given in English. In only a few cases was an abstract in English given of the outstanding papers presented. The French committee had arranged for many features of entertainment, including banquets and sight-seeing trips to Versailles and Fontainebleau. Following the close of the meeting, many of the American delegates visited southern France, through the Pyrenees section and paid a special visit to the home of J. H. Fabre at Serignan, where they were shown through the home and garden by the son who now lives there. A visit was also made to the cemetery where the body of Fabre now lies.

In Italy, Dr. Hinds took advantage of the opportunity to visit Professor Silvestri at Portici, a short distance from Naples. Professor Silvestri speaks several languages fluently, including English, and has visited several times in the United States. It is expected that he will be one of the outstanding foreign entomologists invited by the Chicago Century of Progress Exposition to visit the United States during the coming summer and we look forward to his presence and leadership in sessions of the Association of Economic Entomologists which will be held in Chicago June 20–23, probably.

An invitation was also extended to the Cotton States Entomologists members to attend the summer session of the Economic Entomologists at Chicago in connection with the Chicago Century of Progress Exposition.

The dinner for entomologists and their friends, which was held in a famous restaurant in the French quarter of New Orleans on the night of February 2, proved to be a brilliant occasion. The meeting closed with a tour to places of interest to entomologists in New Orleans. This included a visit to the well-equipped laboratories maintained by the Bureau of Entomology for the investigation of fruit, shade tree and sugarcane insects.

PART I. BUSINESS PROCEEDINGS

The meeting was called to order by Chairman J. W. Folsom at 2:00 P. M., on February 2 in the Roosevelt Hotel at New Orleans, Louisiana. The following were present:

W. E. Anderson, Baton Rouge, La.
F. F. Bondy, Florence, S. C.
M. Brunson, Picayune, Miss.
E. K. Bynum, Houma, La.
T. F. Catchings, New Orleans, La.
K. L. Cockerham, Biloxi, Miss.
A. W. Cressman, New Orleans, La.
E. C. Davis, Baton Rouge, La.
O. T. Deen, Biloxi, Miss.
J. M. Del Curto, Austin, Texas.
W. A. Douglas, Crawley, La.
L. L. English, Spring Hill, Ala.
Alfred Fenton, Houston, Texas.
R. K. Fletcher, College Station, Texas.
J. W. Folsom, Tallulah, La.
J. C. Gaines, College Station, Texas.
J. C. Goodwin, Gainesville, Fla.
W. E. Haley, New Orleans, La.
W. E. Hinds, Baton Rouge, La.
W. B. Hollingsworth, Picayune, Miss.
T. E. Holloway, New Orleans, La.
C. O. Hopkins, Baton Rouge, La.
J. W. Ingram, Houma, La.
H. A. Jaynes, Houma, La.
M. D. Leonard, Orlando, Fla.
B. P. Livingston, Montgomery, Ala.
Clay Lyle, State College, Miss.
J. H. Montgomery, Gainesville, Fla.
C. F. Sarle, Washington, D. C.
C. E. Smith, Baton Rouge, La.
O. I. Snapp, Fort Valley, Ga.
C. L. Stracener, Baton Rouge, La.
F. L. Thomas, College Station, Texas.
G. F. Turnipseed, Spring Hill, Ala.
Fred Wright, Bay St. Louis, Miss.
M. J. Yeomans, Atlanta, Ga.

The report of the Secretary-Treasurer was then read and approved subject to the audit of the auditing committee.

REPORT OF THE TREASURER

Balance on hand February 4, 1932		$160.12
Refund from parent association for expenses for the year ending Feb. 4, 1932		32.63
1929 annual dues from 1 member		1.00
1930 annual dues from 4 members		4.00
1931 annual dues from 5 members		5.00
1932 annual dues from 13 members		13.00
1933 annual dues from 2 members		2.00
Paid Out:		
Stamped envelopes	$ 20.63	
Printing announcements and programs	6.50	
Exchange fee on check	.25	
U. S. tax on 5 checks	.10	
	$ 27.48	$217.75
Balance on hand Feb. 2, 1933	$190.27	

REPORT OF THE SECRETARY

The number of members in the Cotton States Branch on December 31, 1932, was 234. There was a net decrease of only 2 members during the year, after dropping those who had moved out of the Branch territory or were dropped by the parent Association for non-payment of dues. This shows that the Branch membership is being well maintained in spite of present conditions. The membership has grown from 158 to 234 in the last six years or a net increase of 76 members, after dropping those who moved out of the Branch territory during that period or had not kept up their dues in the parent Association. Therefore, the number of new members added

to the Branch roll during the last six years was greater than the number represented by the net increase in the Branch membership.

The number of members by states at the close of 1932 was as follows: Texas 54; Louisiana 34; Mississippi 34; Florida 25; Georgia 20; North Carolina 17; Tennessee 17; South Carolina 11; Alabama 10; Arkansas 7; Oklahoma 5. The following states showed net increases during the year: Texas 3; Louisiana 1; South Carolina 1; Oklahoma 1. The following states showed net decreases during the year: Mississippi 3; North Carolina 2; Florida 1; Arkansas 1; Tennessee 1. There was no net change in the number of members in Alabama and Georgia.

There are now 506 entomological workers in the 11 Cotton States who are not members of the American Association of Economic Entomologists, and members are urged to assist in our efforts to strengthen the Branch by increasing the membership.

The Secretary sent to each member of the Branch an invitation to participate in the regular annual meeting in New Orleans, La., on February 2 and 3, 1933. The program for that meeting was mailed to each member on January 23.

Complying with the action taken at the last annual meeting, one hundred dollars of the balance on hand was deposited to the credit of the Branch in the Savings Department of the First National Bank of Atlanta, Ga.

At a business session of the Branch in 1928, annual dues of $1.00 were established. Fifty-eight members have paid their 1929 dues, 60 have paid their 1930 dues, 63 have paid their 1931 dues, and 24 have paid their dues for last year. Only 3 members have paid their 1933 dues which are now payable.

The Publications Committee called attention to the fact that an abstract must accompany all papers presented for publication in the proceedings of the Branch.

Chairman Folsom announced the committee appointments as follows: Auditing—F. F. Bondy, F. L. Thomas and L. L. English. Executive: Clay Lyle (pro-tem.). Nominations: Clay Lyle, K. L. Cockerham, and F. L. Thomas. Resolutions: W. E. Hinds, T. E. Holloway and R. K. Fletcher. Publications (standing): Oliver Snapp and Herbert Spencer.

Final Business

The final business was transacted on the afternoon of February 3. Chairman Folsom called for the reports of committees.

The Auditing Committee reported that the books and accounts of the Branch had been carefully audited and found to be correct. This report was then adopted by motion and vote and a certificate from the committee given to the Secretary-Treasurer.

The following resolutions were duly adopted after the reading of the report of the committee on resolutions:

WHEREAS, We, the members of the Association of Cotton States Entomologists now meeting in the city of New Orleans, La., have enjoyed a very profitable and

satisfactory annual meeting, and desire to record and to extend the appreciation which we feel to those who have helped to make this gathering a success.

Therefore, Be it Resolved, That our appreciation and thanks be extended to Mr. T. F. Catchings and Mr. A. W. Cressman for the arrangements and menu, to florist E. A. Farley for flowers and to Dr. J. W. Folsom for entertainment, all in connection with the entomologists' dinner enjoyed at Broussards Restaurant, to Mr. T. E. Holloway for the supply of a stereopticon and to the New Orleans entomologists for all of their generous hospitality, including the tour of the city, which we have all enjoyed throughout this gathering.

By unanimous vote of the executive committee called for by the chairman several weeks before the New Orleans meeting, an appropriation of twenty-five dollars was made to defray a part of the expenses of the Secretary-Treasurer in attending the eighth annual meeting. The executive committee also voted that hereafter the expenses of the secretary-treasurer in attending the annual meetings shall be paid out of the treasury, or that at least a part of his expenses shall be so paid, the amount depending upon the condition of the treasury at the time and the discretion of the executive committee.

The Nominations Committee presented the following names for officers during the ensuing year: Chairman—R. W. Leiby, Raleigh, N. C., Vice Chairman—S. W. Bilsing, College Station Texas. These officers were duly elected by motion and vote. Secretary-Treasurer Oliver Snapp was elected in 1931 for a three-year term.

The matter of changing the name of the Branch to Southern States Branch came up for final action. A number of reasons for retaining the old name were advanced by those in attendance, and by motion and vote it was decided that the Branch will continue under the name of Cotton States Branch.

By motion and vote the executive committee was authorized to select the place and time for the next annual meeting.

PART II. PAPERS

The session for addresses and presentation of papers convened immediately following the business session with Chairman Folsom presiding.

THE ECONOMIC IMPORTANCE OF COLLEMBOLA

By J. W. FOLSOM, *Senior Entomologist, Division of Cotton Insects, U. S. Bureau of Entomology*

ABSTRACT

The most serious kinds of damage by springtails are described. All the known injurious species are listed.

The list of injurious species of Collembola, or springtails, is constantly growing. This article lists all the species that are known to be injurious up to the present, and supplements the previous summaries given by Theobald (1911), Collinge (1909, 1910), and Mills (1930).

Collembola are so small that their depredations are often overlooked or attributed to other causes. At times, however, they make up for their small size by immense numbers. They multiply rapidly under favorable conditions, chief of which are humidity and temperature, as expressed in power of evaporation. Collembola soon dry up in a dry atmosphere, and can resist high temperatures only in the egg stage.

The organic matter that forms the food of springtails is obtained from many different sources, as Macnamara (1924) has described in a most readable account. Most springtails are vegetarians.

NATURE OF DAMAGE.—The greatest damage by springtails is done to young, tender plants, especially to seedlings. Some species prefer the upper or the lower surface of a leaf to work on, whereas other species work on either surface. The springtails make irregular holes in leaves, gradually piercing the leaf completely, or characteristically leaving the epidermis at the end of the puncture intact. They feed also at wounds made by flea beetles, potato beetles, and other insects. Sometimes they completely destroy cotyledons and other leaves. In many instances springtails feed collectively, several or many individuals cooperating to enlarge the same opening. Of course, the wounds that they make cause the plant to bleed, and afford entrance to fungi and bacteria.

Many species injure the stems of plants just below the surface of the ground and often cut through them. On roots springtails cause injury by gnawing pits and by destroying root hairs and small rootlets. As a result, the growth of a plant may be stunted. On seeds these insects do more or less damage by eating out pits. On bulbs they not only make pits but also excavate the interior, sometimes completely.

INJURY TO TRUCK CROPS.—In North America a single species of Collembola, *Bourletiella hortensis* (Fitch), has become sufficiently important to receive a popular name—the garden springtail. It is a common species every year and can usually be found on flowers of dandelion.

In occasional years it appears in enormous numbers and becomes a pest of great, though local, importance on seedlings. In May, 1922, as reported by Dr. H. T. Fernald (Brittain, 1924), it raised havoc with onions in Massachusetts, ruining them by eating holes in the leaves and killing 55 per cent of the plants. It has often damaged seedling cucumbers, cabbages, and beets so severely, by eating the leaves and cutting through the stems, that replanting was necessary. In 1920 in Nova Scotia it withered entire fields of mangolds and turnips, almost in a day. One turnip field had to be seeded three times. The same species has been destructive in England (Davies, 1926).

INJURY TO FIELD CROPS.—A related species, *Sminthurus viridis* (L.), "is the most important insect pest of field crops in South Australia today" (Holdaway, 1927). It has several times occurred in countless millions in alfalfa fields. On alfalfa a severe attack gives the field a scorched appearance. This "lucerne flea," as it is called, damages the foliage of many winter fodder plants, particularly alfalfa and clovers, and attacks wheat, oats, and barley as soon as they are through the ground. Its list of food plants includes more than thirty species of cultivated plants, among which are all the common garden vegetables (Holdaway, 1927; Davies, 1928). In the United States, such extensive damage to cereal and forage plants by springtails has been unknown.

INJURY TO SUGARCANE.—Spencer and Stracener (1928, 1929, 1930) proved that several species of Collembola eat pits in the roots of sugarcane. These species are *Pseudosinella* (*Lepidocyrtus*) *violenta* (Fols.), *Onychiurus armatus* (Tull.), and possibly *Proisotoma minuta* (Tull.). *P. violenta* is the worst offender, for it also eats off almost all the fine hairy side roots. The absorption of water and food is greatly hampered by the destruction of secondary roots; consequently the sprout growth was found to average 14 per cent less in affected plants than in unaffected check plants. This kind of root injury is prevalent in all the sugarcane parishes of Louisiana.

The same authors found that *P. violenta* and *O. armatus* (with some assistance from *Symphylella* sp.) caused a marked reduction in the growth and final weight of sugarcane plants, and a slight reduction in the percentage of sucrose. The springtails also impaired germination by eating portions of the buds and bud scales.

Ingram (1931) observed *P. violenta* grazing upon the root hairs of the cane plant. He found also that *Lepidocyrtus cyaneus* Tull. feeds upon a fungus that grows upon sugarcane.

In Hawaii (Muir, 1926; Van Zwaluwenburg, 1926, 1927; Williams, 1931) root tips of sugarcane are heavily pitted by a species of *Isoto-*

modes, which occurs sometimes in immense numbers in the soil. This pitting results in short and stunted roots, which are inadequate for the needs of normal plant growth. The same species works also on pineapple roots.

INJURY TO MUSHROOMS.—In the United States, springtails are pests of major importance on cultivated mushrooms. The chief culprit in this respect is *Achorutes armatus* (Nic.), but other species of *Achorutes*, *Xenylla*, *Schöttella*, and *Isotoma*, along with *Lepidocyrtus cyaneus* and *Sinella höfti* Schäf. are also concerned. All these are soil species, which normally feed on wild agarics and other fungi and which transfer their attacks easily to cultivated mushrooms. These springtails are usually carried into the house with manure (Thomas, 1932), and finding optimum conditions of moisture and temperature, they reproduce rapidly to enormous numbers. They eat the mycelium and may destroy it entirely. Hundreds may gather on a single mushroom and riddle the cap and stem with holes, which give access to fungi and bacteria that cause decay. In one instance, in St. Louis, a mushroom bed 150 feet long was honeycombed and destroyed by springtails.

CONTROL.—"A high percentage of kill has been obtained by the use of a two or three per cent free nicotine-lime dust." (Thomas, 1932.) This kills most of them very quickly. Naphthalene and paradichlorobenzene are very toxic to springtails. Excellent control on mushrooms has been had by nicotine fumigation. Pyrethrum is not so effective. In fields the use of tobacco dust and of air-slaked lime has given good results.

Dryness and high temperatures are, of course, fatal to springtails.

Of some 2,000 species of Collembola that have been described, only about 40 are as yet known to be injurious.

Collembola are of minor economic importance but are of more importance than is generally known.

LIST OF INJURIOUS SPECIES OF COLLEMBOLA

Achorutes armatus (Nic.). A major pest in mushroom beds. Attacks fern roots, narcissus bulbs and bean seeds, seedling beans, peas, and sugar beets. In 1924 it damaged lawns at Miami, Ariz.

Achorutes humi Fols. Found on well water.

Achorutes longispinus Tull. Damages bean seeds and seedlings.

Achorutes macgillivrayi Fols. Injurious in very great numbers in greenhouses.

Achorutes manubrialis Tull. Abundant and injurious in cold frames. Often does great damage to seedling cucumbers, melons, and cauliflower.

Achorutes maturus Fols. In great numbers damaging mushrooms in houses and caves.

Achorutes purpurescens Lubb. Gnaws roots and crowns of young cabbage plants. May kill weak plants.

Achorutes socialis Uzel. Contaminates maple sap.

Achorutes viaticus Tull. Has been beneficial in removing organic deposits from a sewage filter in England.

Allacma fusca (L.). In Theobald's list.

Anurida granaria (Nic.). In Theobald's list.

Bourletiella arvalis (Fitch). Eats pollen of raspberry.

Bourletiella hortensis (Fitch). Sporadically very destructive to truck crops in North America. Food plants: bean, beet, cabbage, cantaloupe, carrot, cauliflower, clover, corn, cucumber, horseradish, kale, lettuce, mangold, onion, pea, potato, pumpkin, radish, rape, rye, soy bean, spinach, squash, sweet peas, tobacco, tomato, turnip, violet, watermelon, wheat, wild cucumber, wormseed. Eats egg masses of the Colorado potato beetle.

Bourletiella lutea (Lubb.). In England it injures young potato tops and turnip leaves. Has done great damage to red currant, feeding on leaves and shoots, and causing the fruit to fall off.

Entomobrya multifasciata (Tull.). Eats pollen of barberry, also spores of fungi.

Entomobrya nivalis (L.). Swarms on currant and feeds on the leaves; in England, damages hops severely.

Folsomia fimetaria (L.). Often so abundant on the surface of well water as to be a nuisance; injures roots of sugarcane.

Folsomia nivalis (Pack.). Abundant in one well.

Heteromurus nitidus (Templ.). May kill strawberry plants, by feeding on roots and bases of leaves (England).

Isotoma sp. Torments poultry; abundant in old nests (England).

Isotomodes denisi Fols. In Hawaii, damages sugarcane roots seriously; also injures pineapple roots.

Isotomurus palustris (Müll.). Injures roots of sugarcane.

Lepidocyrtus cyaneus Tull. Damages mushrooms. Feeds upon a fungus of sugarcane.

Lepidocyrtus violentus. See *Pseudosinella violenta* (Fols.).

Onychiurus ambulans (L.). Injures beans, peas, cauliflower, etc., by eating roots and stems under ground; damages leafstalks of celery; eats into bean seeds; ruins narcissus bulbs.

Onychiurus armatus (Tull.). Attacks seedlings of pea, bean, and sugar beet; injures roots and buds of sugarcane; damages ferns.

Onychiurus fimetarius (L.). Often occurs in swarms, feeding on roots of carrots, potatoes, etc., in damp soil; injures roots of sugarcane.

Onychiurus pseudarmatus Fols. Injurious to roots of newly sown wheat and to roots of vetch.

Onychiurus ramosus Fols. Found on well water.

Orchesella cincta (L.). Destroys seeds and bulblets of orchids.

Podura aquatica L. Five specimens were taken from the stomach of a toad, *Bufo americanus*.

Proisotoma minuta (Tull.). Possibly injurious to roots of sugarcane.

Proisotoma tenella (Reut.). In multitudes on tobacco seedlings, which they destroy.

Pseudosinella violenta (Fols.). Causes serious injury to roots of sugarcane. Damages roots of beets.

Sinella höfti Schäf. Does commercial damage to mushrooms. In one instance caused serious damage to lilies in a greenhouse.

Sira buski Lubb. Infests houses. Feeds on garbage.

Sira nigromaculata Lubb. Infests houses, occasionally becoming a nuisance. Feeds on garbage.
Sminthurides aquaticus (Bourl.). Eaten in large numbers by young brook trout.
Sminthurides malmgreni (Tull.). Eaten in large numbers by young brook trout.
Sminthurinus niger (Lubb.). Injurious, according to Theobald.
Sminthurus sp. Feeds on, and distributes, uredospores of the wheat rust.
Sminthurus viridis (L.). A serious pest of cereal and forage crops in South Australia.
Xenylla humicola (O. Fab.). Often injurious to mushrooms.

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PROGRESS REPORT ON THE DEVELOPMENT OF THE BOLL WEEVIL ON PLANTS OTHER THAN COTTON

By R. C. GAINES, *Entomologist, U. S. Bureau of Entomology, Tallulah, La.*

ABSTRACT

Boll weevils developed to sexual maturity on cultivated althea (*Hibiscus syriacus* L.) and deposited eggs normally in the buds of this plant. Three female weevils developed in, and emerged from, buds of althea. Boll weevil eggs, some of which hatched, were deposited externally on the seed pods of *Hibiscus militaris* Cav. and *H. lasiocarpus* Cav. Larvae that hatched from eggs deposited externally were placed in seed pods of these plants, but soon died, leaving no evidence of feeding. No eggs were deposited on hollyhock (*Althaea rosea* Cav.) or okra (*Hibiscus esculentus* L.).

The original food plants of the boll weevil (*Anthonomus grandis* Boh.) are the tree cottons of Guatemala, Mexico, and Cuba (*4, p. 31*). The native food plant of the Thurberia weevil (*Anthonomus grandis thurberiae* Pierce) is the so-called Arizona wild cotton (*Thurberia thespesioides*) found growing in Arizona, parts of Mexico, and New Mexico (*2, p. 3–4*). The normal food plants of the boll weevil are the cultivated and other cottons belonging to the genus *Gossypium*. In 1913, after the discovery of a boll weevil feeding on cultivated althea (*Hibiscus syriacus* L.) at Victoria, Tex., Coad (*1*) reared two male boll weevils in buds of this plant, noted the partially complete development of the weevil in the buds of two plants belonging to the genus *Callirrhoe* (*C. involucrata* Gray and *C. pedata* Gray), and kept weevils alive for a short period on buds of *Sphaeralcea lindheimeri* Gray. Boll weevils have deposited eggs normally in okra buds and small fruit, but the larvae failed to survive on this food (*3, p. 8–9*). Boll weevils were noted to feed and to deposit eggs externally on the seed pods of several plants belonging to the genus *Hibiscus* (*4, p. 31–32*) and in one instance (*3, p. 10–11*) an egg was deposited normally.

Since legislation to prohibit the planting of cotton during 1932 was considered in several states, evoking widespread interest in the question as to whether the elimination of cotton might result in extermination of the boll weevil, it was deemed advisable to re-investigate the possibility that the boll weevil might develop on plants other than cotton.

The boll weevils used in tests were from three sources—those carried through hibernation, those reared, and those collected in the field. The hibernated weevils had emerged from hibernation in cages, the reared weevils had emerged from cotton squares placed in breeding cages, and the field-collected weevils were from cotton plants growing in the field. Tests were conducted on five species of malvaceous plants growing in

the open field, and with buds, blooms, and seed pods of these plants in the insectary. Tests in the open field were made by confining a definite number of weevils in small organdie sacks on certain portions of a growing plant, and by placing 18 inch by 18 inch by 36 inch screen-wire cages over growing plants to confine the weevils. In the insectary, lantern globes, tumblers, and screen-wire cages about 3 inches in diameter and 3 inches high, with one end open, were used to confine the weevils. The lower, open end of a lantern globe was placed on moist sand, the other end being covered with cheese cloth or screen wire; the tumblers were partly filled with moist sand and covered with cheese cloth or screen wire; and the open end of each small screen-wire cage was pushed into moist sand. The buds, blooms, and seed pods used in lantern-globe, tumbler, and small screen-wire cage tests were placed in small vials of water so that they would remain fresh for a longer time.

TESTS WITH HOLLYHOCK (*Althaea rosea* Cav.).—Hollyhock is grown as an ornamental. The plants bloom and set a seed crop during the spring and early summer and then die down. A total of 18 tests were conducted with hibernated and with reared weevils in the open field, and in the insectary on hollyhock buds, blooms, and seed pods. One weevil was observed feeding on a young seed pod, and there was some evidence of feeding on one bud; otherwise there was no evidence of feeding, and no eggs were deposited. During June the average longevity of 24 hibernated weevils fed on hollyhock blooms and buds was 9.8 days, the longevity range being from 4 to 16 days.

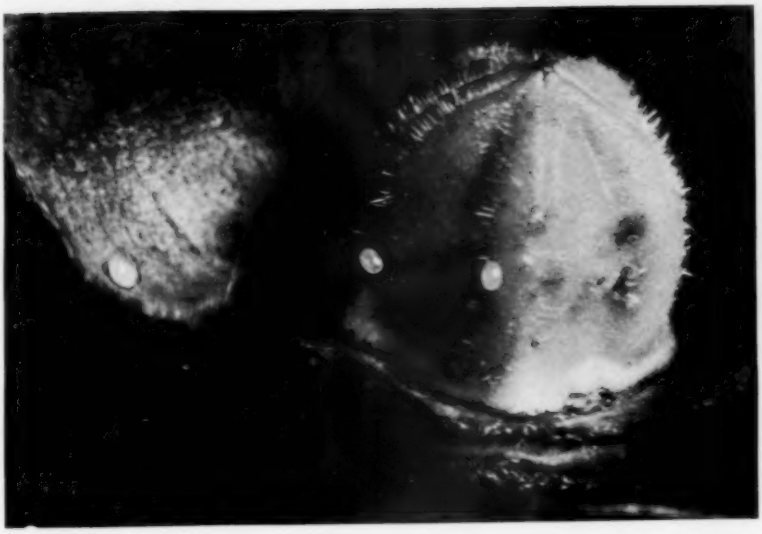
TESTS WITH OKRA (*Hibiscus esculentus* L.).—This cultivated plant is grown generally and is often found in cotton fields or in small garden patches adjoining cotton. A total of nine tests were made on okra with hibernated, reared, and field-collected weevils in the open field and in the insectary. In these tests there was no evidence of feeding, and no eggs were deposited. In August six field-collected weevils lived an average of 5.3 days on young seed pods.

TESTS WITH *Hibiscus lasiocarpus* Cav.—This plant is fairly abundant in Madison Parish, Louisiana in rather low, moist places, such as bayou banks and roadside ditches, and fruits throughout most of the summer. A total of 11 tests were conducted with reared and with field-collected weevils, in the open field and in the insectary. On August 9 seven pairs of field-collected weevils were placed in three tumblers and four small screen-wire cages in the insectary. A young seed pod was placed in each tumbler and cage. From August 9 to 15 a total of nine eggs (three of which are shown in Plate 42, figure 1) were found to have been deposited externally by the seven females. Eight were found on the seed pods and

one on the calyx. Two of these eggs hatched. The young larvae were immediately placed in seed pods but both died in a short time, leaving no evidence of feeding. No eggs were deposited normally. Of the 14 weevils used in this series of tests only 1 lived longer than 6 days; the 13 other weevils lived an average of 4.5 days on seed pods. In some tests weevils were found to feed freely on the blooms and seed pods of this plant, while in others they did not feed, or fed sparingly on the seed pods.

TESTS WITH *Hibiscus militaris* Cav.—This plant is not so common as *H. lasiocarpus* but is found growing under the same conditions. A total of 42 tests were made with hibernated, reared, and field-collected weevils, in the open field and in the insectary. Weevils were found to feed freely on the buds, blooms, and seed pods of this plant. In these tests a total of five eggs were found to have been deposited externally on seed pods by field-collected weevils, and one newly hatched weevil larva was found on the calyx of a seed pod. This larva was immediately placed in a seed pod but soon died, leaving no evidence of feeding. No eggs were found deposited normally.

TESTS WITH *Hibiscus syriacus* L.—This plant is grown quite generally as an ornamental and is a woody perennial commonly called althea. A total of 21 tests on althea were made with hibernated and with reared weevils, in the open field and in the insectary. Weevils fed freely on buds and blooms of this plant. During August 14 of the 18 reared weevils used in one series of tests in the insectary lived an average of 5 days on althea buds. The 4 other weevils lived longer than 7 days. On the 15th of August 20 weevils, 10 females and 10 males, reared from cotton squares were released in a screen-wire cage over a growing althea plant. These weevils had not been permitted to feed on cotton or any other plant before being released in this cage. On August 29 the shed buds and blooms were collected from the floor of the cage and placed in a breeding cage in the insectary for observation. On September 12, 17 (Plate 42, figure 2), and 19, female weevils emerged from three of these althea buds. These three female weevils, paired with three males reared from cotton squares, were immediately placed in three small screen-wire cages over moist sand in the insectary. A fresh supply of althea buds and blooms was kept in these cages at all times. The female weevil that emerged from an althea bud on September 12 escaped on October 12, the female that emerged on September 17 was found dead on October 25, and the female that emerged on September 19 was found dead on October 24. The longevity of these three females was 30+, 38, and 35 days, respectively. These weevils fed freely on althea buds and blooms but no eggs were found to have been deposited by any of the females.



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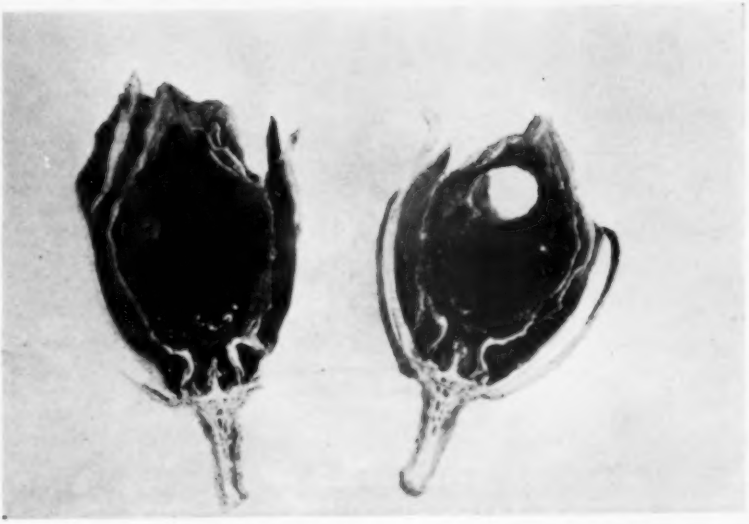

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1—Three boll weevil eggs deposited externally on calyx and seed pod of *Hibiscus lasiocarpus*. Weevil feeding punctures to the right of eggs on seed pod

2—Althea (*Hibiscus syriacus*) bud in which female boll weevil developed and from which it emerged on September 17, 1932. Bud halved to show weevil cell and exit hole.

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SUMMARY.—Boll weevils fed freely on buds and blooms of althea (*Hibiscus syriacus*). Weevils fed freely on buds, blooms, and seed pods of *Hibiscus militaris* and fed on blooms and seed pods of *Hibiscus lasiocarpus*. Weevils fed very sparingly on buds and seed pods of hollyhock (*Althaea rosea*) and were not observed to feed on okra (*Hibiscus esculentus*), though very few tests were made with okra.

Boll weevil eggs, some of which hatched, were deposited externally on the calyx and on the seed pods of *Hibiscus militaris* and *H. lasiocarpus*. The female weevils that deposited these eggs had developed to sexual maturity on cotton and in no case did female weevils become sexually mature on either of these plants. No weevil eggs were deposited on hollyhock or okra. Weevil eggs were deposited normally in althea buds. The females depositing these eggs had developed to sexual maturity on althea. Three female weevils developed in and emerged from althea buds.

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THE EFFECT OF CERTAIN HOMOPTEROUS INSECTS AS COMPARED WITH THREE COMMON MIRIDS UPON THE GROWTH AND FRUITING OF COTTON PLANTS

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ABSTRACT

Three years of cage experiments with four homopterous insects (*Homalodisca triquetra*, *Oncometopia undata*, *Graphocephala versuta*, and *Stictocephala festina*) showed that none of these species, when allowed to feed on cotton plants, was able materially to reduce the normal production of fruit of the plants, or cause typical hopper damage, as did three species of mirids (*Psallus seriatus*, *Lygus pratensis*, and *Adelphocoris rapidus*).

The intensive investigations that have been conducted on the cotton flea hopper, *Psallus seriatus* Reut., during the last few years, have naturally led to investigations on certain other miscellaneous cotton insects.

Previous cage experiments (*1*)[1] showed that three mirids commonly found on cotton, namely, *Psallus seriatus* Reut., *Lygus pratensis* L., and *Adelphocoris rapidus* Say, as well as three other mirids, *Creontiades debilis* V. D., *Poeciloscytus basalis* Reut., and *Lygus apicalis* Fieb., found on cotton only occasionally, are each capable of producing what is commonly called "hopper damage;" that is, they cause dying or abortion of the small squares or floral buds, thus materially reducing the number of live forms that would ordinarily be present on the plants.

In making sweepings to determine the degree of infestation by hoppers in cotton it has been observed that certain homopterous insects were often present in fairly large numbers in many localities in the Cotton Belt. In 1929 and 1930 sweepings were made in a number of cotton fields scattered over Madison Parish, La., and the abundance of four species of homopterous insects and two species of mirids was recorded. The greatest number of each species collected per 100 sweeps in June, July, and August is recorded in Table 1.

TABLE 1. SWEEPING RECORDS SHOWING ABUNDANCE OF TWO MIRIDS AND FOUR HOMOPTEROUS INSECTS ON COTTON IN MADISON PARISH, LA., 1929 and 1930[1]

	Maximum number of insects collected per 100 sweeps					
	1929			1930		
Name of insect	June	July	August	June	July	August
Lygus pratensis	16	6	9	18	14	2
Adelphocoris rapidus	3	5	10	4	5	3
Homalodisca triquetra	53	29	27	3	8	5
Oncometopia undata	22	3	3	0	3	0
Graphocephala versuta	58	49	37	52	42	26
Stictocephala festina	12	3	1	3	3	2

[1]These records were made by L. W. Noble, L. D. Christensen, J. G. Shaw, and E. E. Rogers.

Two of these homopterous insects, *Homalodisca triquetra* Fab. and *Oncometopia undata* Fab., were observed and commented on by several of the earlier cotton insect investigators. In 1897 L. O. Howard (*2*) wrote as follows: "There is a class of damage to the bolls which is known to planters as 'sharpshooter work,' which is mainly caused by the punctures of a leaf hopper known as *Homalodisca coagulata*."[2]

F. W. Mally wrote to E. D. Sanderson (*3, p. 54*): "Replying to your favor of August 11 (1904), making inquiry concerning my observations upon *Homalodisca coagulata* (*triquetra*), I beg to state as follows: * * * the very young are often found in the bud, so-called, of the tender growing tips of the branches on cotton. It is here, while the leaf buds and fruit buds are bunched together and in a formative condition, that the most

[1]Italic numbers in parenthesis refer to Literature Cited at the end of this paper.
[2]Later named *triquetra*.

serious damage is done. The feeding punctures are often not serious enough to shed the squares until they grow out and attain some size."

Sanderson sums up his observations on *Homalodisca triquetra* as follows: "* * * we are forced to conclude that the possible injury to the cotton plant from this insect and those to be discussed below which might easily be confused with it[3] is inconsiderable."

Observations of earlier entomologists differ somewhat on the probable damage to cotton from *H. triquetra* and *O. undata*. There are no specific data published showing definitely whether or not these insects can cause cotton plants to shed their fruit. Since investigations in recent years have implicated several species of mirids in "hopper damage," it was deemed advisable to determine positively whether certain of the Homoptera commonly found abundant in cotton fields were capable of producing a similar damage. The necessity for these investigations increased as inquiries regarding this became more numerous.

A preliminary experiment was conducted in 1928 to ascertain whether it would be possible to work with this group of insects under cage conditions. In this experiment the homopterous insects under observation behaved more normally under cages than did the mirids.

Cage experiments were started in 1929 and continued through 1931 with four of these insects, *Homalodisca triquetra*, *Oncometopia undata*, *Graphocephala versuta*, and *Stictocephala festina*, to compare their possible damage with that caused by three mirids, namely, *Psallus seriatus*, *Lygus pratensis*, and *Adelphocoris rapidus*. The above-named Homoptera were chosen because of their abundance on cotton during the growing season.

The methods of experimentation during each year, 1929, 1930, and 1931, were essentially the same, with the exception that in 1929 the cages were constructed of 16-mesh wire screen or of cloth and glass, whereas in 1930 and 1931 they were constructed of 16-mesh or 24-mesh screen.

In 1929 comparisons were made of different cages to determine under which type a cotton plant would make the most normal growth. Five types of cages were used, constructed of the following materials: "Cloth-glass," "celo-glass," 16-mesh galvanized screen, 24-mesh brass screen, and cloth and glass. Temperature and humidity records made in the cages gave a good basis for comparisons. On account of the fact that the 24-mesh screen cage was not constructed until late in the season, only temperature records for comparing the 24-mesh screen with the 16-mesh screen were made in this cage. Table 2 gives the results of the humidity

[3]He refers here to *Oncometopia undata*.

and temperature readings made in the five types of cages experimented with in 1929. These records, as well as observations on the normal growth and fruitage of the cotton plants in the cages, showed that the screen cages were the most suitable for the experiments. It was also noted that for all practical purposes there was no difference in the growth and fruitage of the plants grown in the 16-mesh galvanized screen cage compared with those in the 24-mesh brass screen cage.

TABLE 2. COMPARISON OF TEMPERATURE AND HUMIDITY RECORDS IN CAGES OF DIFFERENT TYPES. TALLULAH, LA., 1929

		Temperature			Humidity		
Type of cage	Dates of records	Morning (8.00-9.00 a.m.)	Noon (11.30 a.m.-1.00 p.m.)	Evening (4.30-6.00 p.m.)	Morning (8.00-9.00 a.m.)	Noon (11.30 a.m.-1.00 p.m.)	Evening (4.30-6.00 p.m.)
Open air	July 13 to Aug. 16, incl.	—	—	—	76.9	64.5	66.2
16-mesh screen	July 13 to Aug. 16, incl.	81.6	89.4	87.2	76.1	63.5	66.4
"Cloth-glass"	July 13 to Aug. 16, incl.	86.7	94.7	92.4	74.3	61.7	66.7
"Celo-glass"	July 13 to Aug. 16, incl.	87.6	95.9	92.6	72.6	60.4	63.7
Cloth and glass	July 13 to Aug. 16, incl.	95.4	106.3	99.2	70.0	57.1	64.9
16-mesh screen	Oct. 15 to 29, incl.	66.6	79.7	70.4	—	—	—
24-mesh screen	Oct. 15 to 29, incl.	65.9	78.7	70.5	—	—	—

The 24-mesh screen was sufficiently fine to retain the smallest insect used, *Psallus seriatus*. On account of the initial cost of the 24-mesh brass screen only about one-half of the cages were covered with this material, and the remainder were constructed of 16-mesh galvanized screen. In each series of experiments during 1930 and 1931, the mirids were confined under 24-mesh cages and the Homoptera under 16-mesh cages.

The details of the experiments of only one year (1931) will be discussed here, with a general summary given of the results during the other two years (1930 and 1929).

In 1931 the cotton for the experiments was planted on May 26, on the experimental plot in the rear of the laboratory buildings, 2½ miles south of Tallulah, La. The variety of cotton used was Delfos 6102–38, Strain 2. The cages were placed over the cotton soon after it was "chopped" and about 10 days before the experiments were started. The plants for each cage were selected with a view to their being as nearly uniform as possible, and three were inclosed in each cage. The uniformity of the soil was also considered in selecting the plants for the

cages. All plants were dusted with a heavy application of nicotien sulphate, immediately after being caged, to kill all aphids. Care was taken throughout the experiments to see that no insect other than the one introduced had access to the plants under observation.

A total of 16 cages were used in this series of experiments, two cages for each of the following insects: *Lygus pratensis*, *Adelphocoris rapidus*, *Psallus seriatus*, *Homalodisca triquetra*, *Oncometopia undata*, *Graphocephala versuta*, and *Stictocephala festina*, and two check cages. The insects were introduced into their respective cages on June 30, at which time a record was made of the live forms present on the plants and the height of the plants. Inspections of the plants were made at 2 or 3 day intervals to note the forms that were shed, and weekly examinations were made to determine the live squares and bolls present on the plants, and the plant heights. All of these records were summarized and are shown in Tables 3 and 4 as weekly interval readings. As each cage contained 3 cotton plants, the figures shown in Tables 3, 4, 5, and 6 are the averages of 6 plants for each insect listed as well as for the checks.

TABLE 3. WEEKLY EXAMINATIONS SHOWING THE NUMBER OF LIVE FORMS ON THE PLANTS AND PLANT HEIGHTS IN THE CHECK CAGES AS COMPARED WITH THE PLANTS EXPOSED TO EACH OF THE THREE SPECIES OF MIRIDS AND FOUR SPECIES OF HOMOPTEROUS INSECTS. EACH RECORD IS AN AVERAGE OF 6 COTTON PLANTS. TALLULAH, LA., 1931

Date	Check	Lygus pratensis	Adelphocoris rapidus	Psallus seriatus	Homalodisca triquetra	Oncometopia undata	Graphocephala versuta	Stictocephala festina
				Live forms present				
				Squares				
June 30	1.9	2.0	2.0	1.2	2.7	2.2	2.3	2.7
July 7	9.0	1.9	4.4	6.9	12.9	10.7	11.9	10.7
July 14	20.5	2.2	8.0	14.7	25.7	21.0	26.0	19.5
July 21	31.2	1.9	10.2	16.9	30.5	32.4	33.2	28.7
July 28	38.4	1.2	7.0	18.4	38.2	40.5	46.4	25.3
Aug. 4	48.9	1.0	7.8	17.5	49.4	51.0	58.2	34.0
				Bolls				
June 30	0	0	0	0	0	0	0	0
July 7	0	0	0	0	0	0	0	0
July 14	0	0	0	0	0	0	0	0
July 21	0	0	0	0	.7	.7	.5	.5
July 28	3.0	0	0	1.9	5.2	4.2	3.2	2.8
Aug. 4	8.2	.2	.7	5.9	9.0	9.7	9.3	7.9
				Plant height (inches)				
June 30	8.9	10.5	8.5	8.9	10.0	9.2	9.5	9.8
July 7	14.3	12.0	12.0	13.5	15.0	14.7	15.2	15.8
July 14	21.7	14.5	18.4	20.0	20.7	21.0	22.4	20.5
July 21	30.5	19.4	26.3	28.3	27.2	29.2	31.5	25.3
July 28	38.7	24.0	33.5	34.5	32.5	36.0	40.0	30.0
Aug. 4	48.0	30.7	42.0	43.0	37.9	42.5	46.4	34.0

Previous experiments had shown that the mortality of these insects, especially the mirids, when confined under a large cage was comparatively high: also, that they did not reproduce enough to keep up a normal infestation on the cotton plants. Consequently additional insects were introduced at irregular intervals from June 30 to August 4, to keep the average infestation of each species in the cages up to a standard, which might ordinarily be called a "heavy field infestation."

For example, 32 introductions were made in the cages containing *A. rapidus* with an average total of 197.5 insects introduced per plant during the experiment. In the case of *H. triquetra*, 14 introductions were made with an average total of 108.7 insects introduced per plant from June 30 to August 4. As a whole the mortality of the homopterous insects, especially *O. undata* and *H. triquetra*, was considerably below that of the mirids. In the case of *H. triquetra*, which was the insect easiest to handle and count inside the cages, the average population per plant ranged from about 10 to 25.

On June 30, when the experiment started, the plants exposed to the different species of insects were entirely comparable, both as to height and live squares present. (Table 3.) The live squares per plant ranged from a minimum of 1.2 in the *P. seriatus* cages (all figures referring to the plant data of 1931 are the average of 6 plants) to a maximum of 2.7 in the *H. triquetra* and *S. festina* cages, respectively. The plant heights ranged from 8.5 inches in the cages containing *A. rapidus* to 10.5 inches in the cages containing *L. pratensis*.

The live squares and bolls (blooms counted as bolls) and plant heights as determined at weekly intervals from June 30 to August 4 are shown in Table 3. The dead forms removed, including "hopper squares" and naturally shed squares and bolls, are recorded in Table 4. It may be well to state here that the term "hopper square" refers to the small floral buds, or squares, that are blasted by the feeding of plant-sucking insects. These squares range in size from as small as an ordinary pinhead to about 4 or 5 millimeters in width. Vigorous cotton plants growing under favorable conditions and without adverse outside influence do not ordinarily shed squares at this stage. Often, when cotton plants reach maturity with a full crop of bolls and large squares on them or when droughts, lack of plant food, or other factors cause an unfavorable physiological condition, they will naturally shed a certain number of small squares. These small naturally shed squares can usually be distinguished from hopper squares. They are a little larger than the usual hopper square; the smallest being as large as, or larger than, the largest hopper square. Moreover, they are usually yellow, like ordinary

weather-shed forms, especially when removed from the plant within a day or two after dying; whereas the hopper squares are usually dark brown or black when shed. In these experiments there were a few small naturally shed squares removed from most of the plants that retained any considerable amount of their fruit, in which instances these shed squares are recorded as naturally shed squares or forms.

TABLE 4. WEEKLY EXAMINATIONS SHOWING THE NUMBER OF HOPPER SQUARES AND NATURALLY SHED SQUARES AND BOLLS REMOVED FROM THE CHECK CAGES AS COMPARED WITH REMOVALS FROM CAGES CONTAINING THE THREE SPECIES OF MIRIDS AND FOUR SPECIES OF HOMOPTEROUS INSECTS. EACH RECORD IS AN AVERAGE FROM 6 COTTON PLANTS. TALLULAH, LA., 1931

Date	Check	Lygus pratensis	Adelphocoris rapidus	Psallus seriatus	Homalodisca triquetra	Oncometopia undata	Graphocephala versuta	Stictocephala festina
				Dead forms removed				
				Hopper Squares				
June 30	0	0	0	0	0	0	0	0
July 7	0	4.9	1.8	0	0	0	0	0
July 14	0	4.3	2.9	1.2	0	0	0	.5
July 21	0	5.2	6.7	6.2	0	0	0	1.0
July 28	0	8.0	7.3	5.4	0	0	0	3.0
Aug. 4.	0	6.0	5.7	7.4	0	0	0	1.2
Total	0	28.4	24.4	20.2	0	0	0	5.7
				Naturally shed				
				Squares				
June 30	0	0	0	0	0	0	0	0
July 7	.3	0	0	.2	0	0	0	0
July 14	.2	0	0	0	0	0	0	0
July 21	.4	0	.4	0	0	.3	0	.9
July 28	.2	.5	1.0	1.2	.5	.2	0	2.3
Aug. 4	1.0	1.0	1.9	1.0	.4	.4	.5	.7
Total	2.1	1.5	3.3	2.4	.9	.9	.5	3.9
				Bolls				
June 30	0	0	0	0	0	0	0	0
July 7	0	0	0	0	0	0	0	0
July 14	0	0	0	0	0	0	0	0
July 21	0	0	0	0	0	0	0	0
July 28	0	0	.2	0	.4	.5	.7	.2
Aug. 4	.3	0	0	.5	1.9	.5	1.0	.5
Total	.3	0	.2	.5	2.3	1.0	1.7	.7

Later experiments have shown that *Lygus pratensis* and *Adelphocoris rapidus* are capable of causing large squares to shed. It should be remembered, however, that in this group of experiments the insects started feeding on the plants before the squares reached any appre-

ciable size, consequently the damage was done primarily to the small squares just as they were being formed.

In fact, as will be noted from Table 4, there were very few naturally shed squares (including both small and large) taken from any of the cages in 1931; the lowest average being 0.5 from the cages containing *G. versuta* and the highest 3.9 from the *S. festina* cages.

Table 5 gives a summary of the results of the series of experiments of 1931. It will be noted that the plants in the check cages bore an average of 1.9 live forms at the beginning of the experiment and 57.1 forms at the conclusion, and that the average in the cages of *L. pratensis* fell from 2.0 at the beginning to 1.2 at the conclusion. The cages containing *G. versuta* had the largest average number of forms at the conclusion of the experiment.

The largest average number of hopper squares removed from the plants under any of the cages during the experiment was from those containing *L. pratensis*.

TABLE 5. SUMMARY SHOWING THE TOTAL DEAD FORMS REMOVED AND THE TOTAL LIVE FORMS PRESENT AND PLANT HEIGHTS AT THE BEGINNING AND CONCLUSION OF THE EXPERIMENT IN THE CHECK CAGES AND IN EACH OF THE CAGES CONTAINING SPECIES OF MIRIDS AND OF HOMOPTEROUS INSECTS. EACH RECORD IS AN AVERAGE FROM 6 COTTON PLANTS. TALLULAH, LA., 1931

Species	Total live forms		Total dead forms removed		Plant height (inches)		
	Beginning (June 30)	Conclusion (Aug. 4)	Hopper squares	Naturally shed	Beginning (June 30)	Conclusion (Aug. 4)	Increase in height
Check	1.9	57.1	0	2.3	8.9	48.0	39.1
Lygus pratensis	2.0	1.2	28.3	1.5	10.5	30.7	20.2
Adelphocoris rapidus	2.0	8.5	24.4	3.4	8.5	42.0	33.5
Psallus seriatus	1.2	23.4	20.1	2.8	8.9	43.0	34.1
Homalodisca triquetra	2.7	58.4	0	3.1	10.0	37.9	29.9
Oncometopia undata	2.3	60.7	0	1.8	9.2	42.5	33.3
Graphocephala versuta	2.3	67.5	0	2.2	9.5	46.4	36.9
Stictocephala festina	2.7	41.9	5.7	4.5	9.8	34.0	24.2

The average increase in the height of the plants in the different cages during the experiment ranged from 39.1 inches in the check cages down to 20.2 inches in those containing *L. pratensis*.

The cage experiments of 1929 and 1930 with the same species of insects had given essentially the same results as those reported for the experiments of 1931.

Table 6 gives a brief summary of the results of the experiments of 1930. It will be noted that there was more natural shedding in each cage in 1930 than in 1931. This would be expected, as the plants of the

1930 series were further advanced when the experiment started than were those of 1931 (average number of live forms in 1930 was 13.8; in 1931, 2.1), and the plants were more mature in 1930 at the conclusion of the experiment. There was more natural shedding from the plants containing a full crop of fruit (check cages and cages containing homopterous insects) than from the plants exposed to mirids, where a certain amount of the fruit was continually being stripped from the plants by the insects. In 1930 the average number of naturally shed forms per plant in the cages containing the homopterous species was 14.0; in the check cages, 13.8; and in the cages containing the mirids, 8.4. At the conclusion of the experiment the average number of live forms per plant in the cages containing the homopterous insects was 69.8; in the check, 70.7; and in the mirid cages, 29.4.

TABLE 6. SUMMARY SHOWING THE TOTAL DEAD FORMS REMOVED, THE TOTAL AND INCREASES IN LIVE FORMS PRESENT, AND PLANT HEIGHTS AT THE BEGINNING AND CONCLUSION OF THE EXPERIMENT IN CHECK CAGES AND THOSE CONTAINING THREE SPECIES OF MIRIDS AND FOUR SPECIES OF HOMOPTEROUS INSECTS. AVERAGE OF 6 COTTON PLANTS. TALLULAH, LA., 1930

Species	Live forms			Shed forms		Plant height (inches)		
	Beginning (July 7–8)	Conclusion (Aug. 6)	Increase	Hopper squares	Naturally shed	Beginning (July 7–8)	Conclusion (Aug. 6)	Increase
Check	8.9	70.7	61.8	0	13.8	21.0	51.5	30.5
Lygus pratensis	14.9	24.2	9.3	49.5	6.8	18.5	35.7	17.2
Adelphocoris rapidus	9.7	24.9	15.2	41.6	6.6	18.0	44.2	26.2
Psallus seriatus	9.4	39.0	29.6	24.0	11.7	22.5	54.4	31.9
Homalodisca triquetra	18.7	78.7	60.0	0	14.2	20.7	45.2	24.5
Oncometopia undata*	16.3	58.6	42.3	0	15.0	18.7	43.0	24.3
Graphocephala versuta	16.0	66.2	50.2	0	15.2	17.2	46.4	29.2
Stictocephala festina	18.2	70.0	51.8	10.0	12.0	17.2	38.7	21.5

*Average of 3 plants.

A brief summary of the results of the three years of cage experiments with the four species of homopterous insects as compared with the three species of mirids follows.

Psallus seriatus produced typical "hopper damage." (See Plate 43, C.) Numerous small squares or "hopper squares" were shed as a result of the feeding of this insect on the buds or in the terminals of the main stem and branches, thereby materially reducing the number of live forms that would normally have been present on the plants; and feeding punctures caused a great number of lesions to appear on the main stems, branches, and leaf petioles and caused mutilation of the leaves. There was very

little difference in the height of the plants exposed to this insect as compared with the check plants.

Adelphocoris rapidus produced the same typical "hopper damage" as that described above for *P. seriatus*. (See Plate 43, A.) The damage was noticeably more severe in the cages exposed to this insect than in the *P. seriatus* cages. This was due to the fact that at times the infestation of *P. seriatus* dropped below normal, and that, per individual, *A. rapidus* is more injurious than *P. seriatus*.

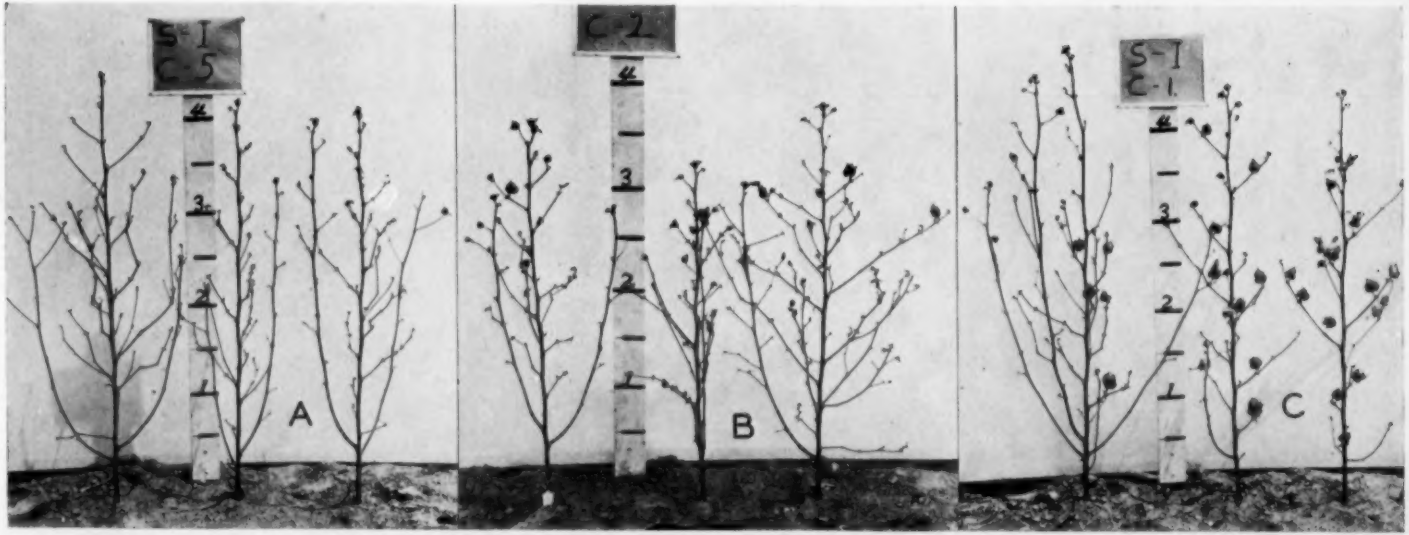
Lygus pratensis also caused injury similar to that produced by *P. seriatus* and *A. rapidus*. In addition, the plants exposed to this insect had a general "bushy" appearance, the growth in height of the plants being considerably retarded; there was also an excess of foliage and erratic branching. (See Plate 43, B.)

The cotton plants exposed to *Homalodisca triquetra* fruited normally. (See Plate 44, A.) There were no hopper squares removed from the plants. In some instances small lesions were caused by this insect, but they were few considering the number of food punctures made. There was a slight retardation in the growth of the plants, as evidenced by the plant-height records. Observations on the feeding habit of this insect showed that it fed on the stems and petioles, practically never feeding on the fruit or in the terminal buds. In several of the cages a generation of nymphs was reared on the plants from eggs deposited by the adults that were introduced. In no instance were they observed to feed in the buds sufficiently to cause the blasting of small squares. The fact that this insect is capable of producing small lesions at the point of puncture shows that its feeding is probably slightly toxic although in no way comparable to that of the mirids.

Plants exposed to *Oncometopia undata* fruited normally and did not shed any hopper squares. (See Plate 44, B.) In fact, what has been said of *H. triquetra* applies also to this insect with the exception that *O. undata* did not retard the growth of the plants quite so much as did *H. triquetra*.

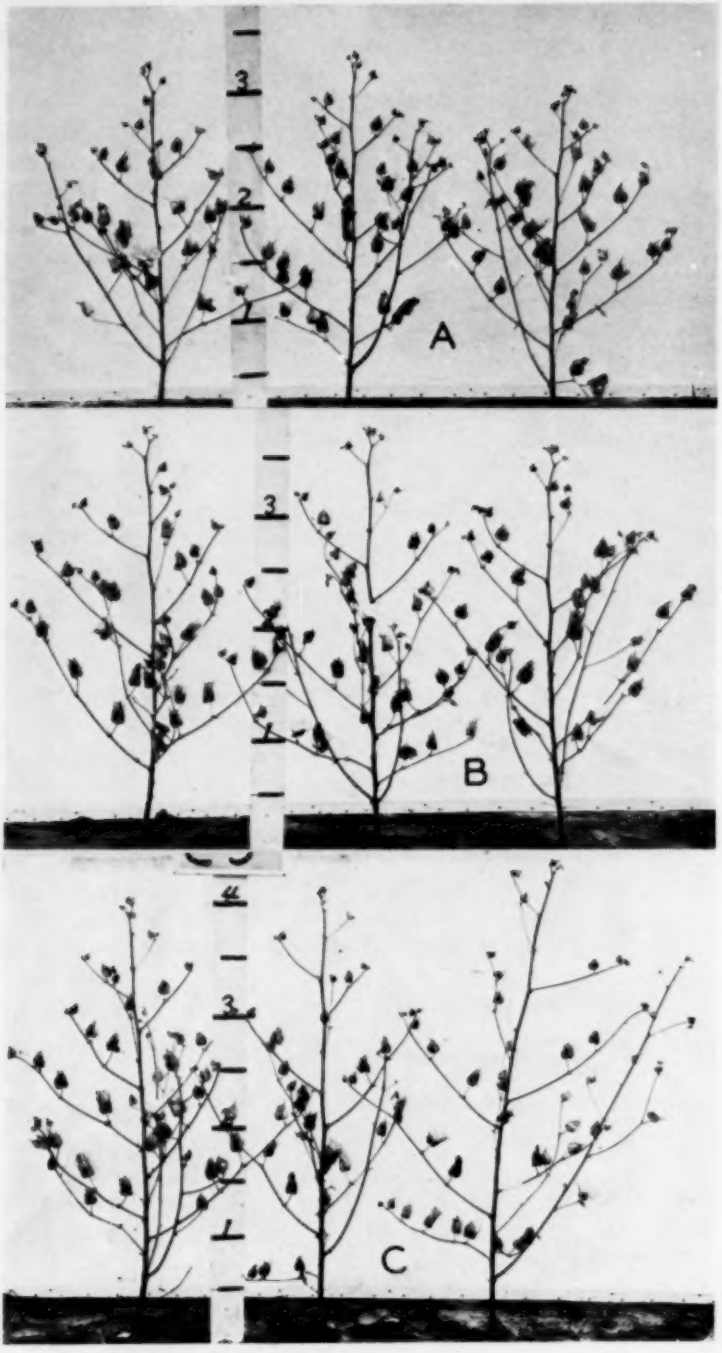
The tests conducted with *Graphocephala versuta* showed no evident damage to the cotton plant either in loss of fruit or abnormality of growth. (See Plate 44, C.)

The feeding punctures of *Stictocephala festina* are probably more toxic than those of any of the other Homoptera experimented with. Its peculiar habit of making rings of feeding punctures around petioles and stems often causes an abnormal growth. The stems or petioles so fed around or "ringed" usually grow at an angle from this point or sometimes break entirely off. (See Plate 45, B.) This is the most serious

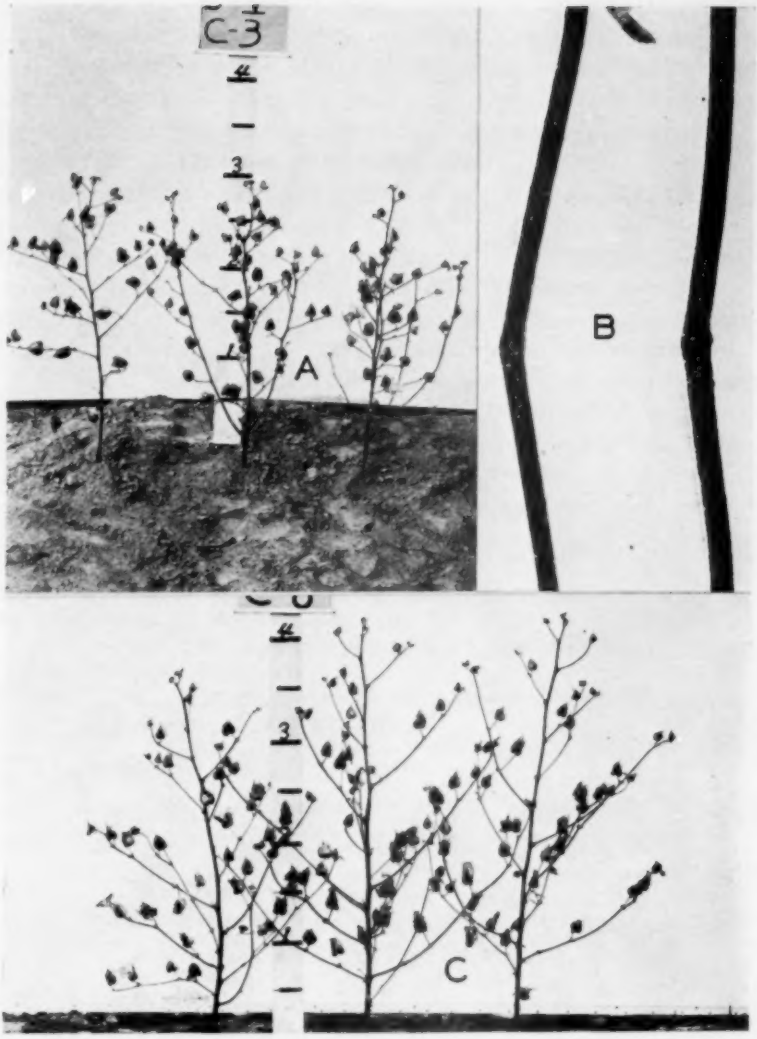


Cotton plants exposed to feeding by mirids for five weeks: A, Effect of feeding by *Adelphocoris rapidus;* B, by *Lygus pratensis;* C, by *Psallus seriatus.* The leaves have been removed to show branching and lack of fruit. Tallulah, La., 1931.

Plate 44



Cotton plants exposed to feeding by homopterous insects for five weeks: A, Effect of feeding by *Homolodisca triquetra;* B, by *Oncometopia undata;* C, by *Graphocephala versuta.* The leaves have been removed to show branching and abundance of fruit. Tallulah, La., 1931.



A. Cotton plants exposed to *Stictocephala festina* for five weeks (note a full crop of fruit); B. two cotton leaf petioles showing abnormal growth from the peculiar feeding habit of *S. festina* (note the swelling and change in direction of growth at the point where the insect fed around or "ringed" the petioles); C. cotton plants from which all insects have been excluded for five weeks (note a full crop of fruit). The leaves have been removed to show branching and fruit. Tallulah, La., 1931.

injury that this species causes to the cotton plant, although a few hopper squares were taken from each plant (average of 5.7 in 1931 and 10.0 in 1930). The plants exposed to this insect fruited normally, or at least the few hopper squares shed from the plants because of this insect were not enough to materially affect the final or total production of fruit. (See Plate 45, A.) Lesions were fairly common on the stems and petioles, and the growth of the plants was noticeably retarded.

For an illustration of normal growth and fruitage of cotton plants from which insects were excluded (checks) see Plate 45, C.

In the final analysis, the economic importance of insects that feed on the cotton plant is measured by their effect in keeping the plant from producing and maturing a full crop of cotton. The homopterous insects experimented with, namely, *Homalodisca triquetra*, *Oncometopia undata*, *Graphocephala versuta*, and *Stictocephala festina*, did not produce any material injury to the cotton plant, and the plants exposed to them were able to mature a full crop of cotton; whereas the mirids, *Psallus seriatus*, *Adelphocoris rapidus*, and *Lygus pratensis*, severely injured the cotton, in most instances causing the loss of almost all the fruit.

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DAMAGE TO THE COTTON PLANT CAUSED BY *MEGALOPSALLUS ATRIPLICIS* KNGT. AND OTHER SPECIES OF MIRIDAE

By R. L. McGarr, *Junior Entomologist, Division of Cotton Insects, U. S. Bureau of Entomology*

Abstract

Experiments have proved that *Megalopsallus atriplicis*, when allowed to feed on cotton, causes blasting or abortion of the young squares, and induces swellings and lesions on the stems and petioles and malformation of the leaves; and that *Psallus biguttulatus*, *P. pictipes*, *Reuteroscopus ornatus*, *Lygus cristatus*, *Megalopsallus latifrons*, and *Melanotrichus leviculus* cause swellings and lesions on the stems and petioles similar to those produced by *Psallus seriatus*.

Megalopsallus atriplicis Kngt., sometimes referred to as the "*Atriplex* hopper," is very similar to the cotton flea hopper, *Psallus seriatus* Reut.,

the similarity being so pronounced that some investigators have been at a loss to distinguish between the two. In fact, no distinction was made until 1927, when H. H. Knight separated the two species and described the new genus *Megalopsallus* (*3*). *M. atriplicis* occurs principally on the Atriplex plant, which is a perennial and commonly represented along the southeastern coast of Texas by the species *A. matamorensis*.

Experiments were conducted at Brownsville, Tex., in 1930, to determine primarily the feeding effect of *M. atriplicis* on cotton. Six other species of Miridae, namely, *Psallus biguttulatus* Uhl., *P. pictipes* V. D., *Reuteroscopus ornatus* Reut., *Lygus cristatus* Dist., *Megalopsallus latifrons* Kngt., and *Melanotrichus leviculus* Kngt., in addition to *Psallus seriatus* (which was used as a check), were included in the experiments for comparative observations. All the tests were run on cotton protected by 4 by 4 by 4 foot cages covered with 16-mesh wire screen.

Three feeding methods were used, namely, the "24-hour," the "observed," and the "bag." As these methods are described in other papers (*1*), (*2*), only a brief discussion will be given here. In the first, or "24-hour" method, exposures were made for 24 hours with individual insects confined in small glass vials attached with adhesive tape. The limits of exposed areas were then marked with India ink to insure later identification, and after five daily examinations those petioles with no apparent swellings or lesions were sectioned and examined microscopically for internal injury. It is interesting to note that with this method external injury in the form of swellings or lesions was usually evident.

In the second, or "observed" method, attention was given to the length of the feeding period and character of the feeding. To induce feeding the insect was usually starved for a few hours prior to exposure and after five daily examinations all exposed areas were sectioned and the internal damage was studied microscopically.

In the third, or "bag" method, exposures were usually made for 72 hours with several hoppers introduced into each of several small muslin bags placed over the tips of the main stems and branches. The exposed areas were examined for five days after the removal of the insects, and blasted or otherwise damaged squares were especially noted.

The experiments with *Megalopsallus atriplicis* will be considered first. In 57 "24-hour" feeding tests with 21 adults on petioles, 47 instances of external injury and 6 of internal injury were observed, 2 tests showed neither external nor internal injury, and the results in 2 were doubtful. In 30 similar tests with 15 nymphs, 21 petioles with external injury and 3

with internal injury were observed, 5 showed neither external nor internal injury, and 1 was doubtful. Summarizing: In 87 "24-hour" tests with 36 adults and nymphs on petioles, 77 tests showed injury; 7, no injury; and 3 were doubtful. The percentages of petiole injury by adults was 93; by nymphs, 80; and both adults and nymphs, 88.5.

In 20 "24-hour" tests with 8 adults, each on a small square, 4 squares were blasted, whereas the others showed very little if any damage. Seven similar tests with 5 nymphs, each on a square, showed 3 blasted squares and but slight if any damage to the others.

In 18 "observed" feeding tests with 14 adults and 4 nymphs on petioles, 12 instances of internal and 3 of external injury were observed, and in the remaining 3 tests injury was doubtful.

The results of 43 "bag" feeding tests made chiefly on the tips of fruiting branches may be summarized as follows: Swellings or lesions were common on the stems, petioles, and midribs; 12 squares were blasted; 8 squares were doubtful as to the cause of shedding; and 21 squares showed external injury but not of sufficient severity to cause blasting or abortion. In these tests a total of 1,634 adults and nymphs were used, the maximum per bag being 108; the minimum, 22; and the average, 38.

Psallus seriatus is known to cause the blasting of young cotton squares, and to produce swellings or lesions on the stems and petioles and malformation of the leaves—a type of injury commonly called "hopper damage." Therefore, experiments with this species were run primarily as a check against the others. Twenty-seven "24-hour" feeding tests with 13 adults on petioles resulted in 21 instances of external injury and 6 of internal injury. Twelve similar tests with 7 nymphs resulted in external injury on 7 petioles and internal injury on 4, while 1 petiole showed neither external nor internal injury. Summarizing: A total of 39 "24-hour" tests with 20 adults and nymphs on petioles showed 38 instances of injury and only 1 instance of no injury. The percentages of injury by *P. seriatus* adults was 100; by nymphs, 91.7; and by both adults and nymphs, 97.4.

Experiments with the remaining six species, which do not ordinarily occur on cotton, were made primarily for the purpose of determining whether they were capable, when allowed to feed on cotton, of producing injury. All of these experiments were of the "24-hour" feeding type and were conducted for the most part with adults on petioles.

Thirteen feeding tests with 10 adults of *Psallus biguttulatus* resulted in external injury to 5 petioles and internal injury to 8. Six similar tests with 4 nymphs showed 4 petioles with external injury and 1 with internal injury, while 1 showed no injury. The percentages of injury by

adults was 100; by nymphs, 83.3; and by both adults and nymphs, 94.7. With the remaining 5 species all of the "24-hour" feeding tests on petioles resulted in some injury, usually in the form of external swellings. The number of feeding tests with each species was as follows: *Psallus pictipes*, 21 with 10 adults; *Reuteroscopus ornatus*, 9 with 6 adults; *Lygus cristatus*, 13 with 10 adults; *Megalopsallus latifrons*, 9 with 4 adults; and *Melanotrichus leviculus*, 3 with 2 adults.

It may also be well to mention that since there is no marked difference between the character of injury to petioles and stems, the younger petioles as a rule were used for study and for sectioning, as they contained less woody tissue than did the stems. The results of all the "24-hour" feeding tests on petioles and stems are shown in Table 1.

TABLE 1. RESULTS OF "24-HOUR" FEEDING TESTS WITH *Megalopsallus atriplicis* AND OTHER SPECIES OF MIRIDAE ON COTTON PETIOLES AND STEMS

Species	Stage	Individuals *Number*	Tests *Number*	Petioles injured *Number*	*Per cent*	Petiole injury with external lesions or swellings *Per cent*
Megalopsallus atriplicis	Adult	21	57	53	93.0	82.5
	Nymph	15	30	24	80.0	70.0
	Both	36	87	77	88.5	78.2
Psallus seriatus	Adult	13	27	27	100.0	77.8
	Nymph	7	12	11	91.7	58.3
	Both	20	39	38	97.4	71.8
Psallus biguttulatus	Adult	10	13	13	100.0	38.5
	Nymph	4	6	5	83.3	66.7
	Both	14	19	18	94.7	47.4
Psallus pictipes	Adult	10	21	21	100.0	90.5
Reuteroscopus ornatus	Adult	6	9	9	100.0	77.8
Lygus cristatus	Adult	10	13	13	100.0	38.5
Megalopsallus latifrons	Adult	4	9	9	100.0	88.9
Melanotrichus leviculus	Adult	2	3	3	100.0	100.0

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FACTORS INFLUENCING THE ACTIVITIES OF THE COTTON BOLLWORM MOTH (*HELIOTHIS OBSOLETA* FAB.)

By J. C. GAINES, *Entomologist, Texas Agricultural Experiment Station*[1]

ABSTRACT

Continued observations on the activities of the cotton bollworm moth show that the growth of the cotton as indicated by the plant height and fruiting are factors that influence the moth and egg population. The migratory habits, time of flight, and proportion of sexes are also discussed.

A preliminary report dealing with the activities of the cotton bollworm moth (*Heliothis obsoleta* Fab.) during the season of 1931 has been published (*1*). The purpose of this paper is to add some information to that given in the previous paper and to present observations that were recorded during the season of 1932.

Since the occurrence of "spotted" infestations of the bollworm makes it difficult to know when to apply control measures, it is thought that information concerning the factors that influence the moth and egg population is important. It has been shown (*3*) that there is no relation between the infestation of this insect in cotton and the proximity to corn and that nectar and honeydew are unimportant factors. During the season of 1931 there apparently was no relation between the large moth catch and the comparatively small number of eggs, which was probably due to the drifting, or migration, of moths from field to field while seeking cotton more desirable for oviposition.

The two-wheel-cart type of trap (*1*) was again used during the season of 1932 to obtain information on the migration and the abundance of moths in two fields of cotton. Fields showing contrast in the condition of growth were selected. In one field, designated as rank, the cotton grew faster and produced more fruit than in the field designated as small.

During the period from July 4 to August 22, 1932, 284 moths were captured in the trap from the two fields. Two hundred and nine of these moths were marked before release in such a way that the date of release could be ascertained if they were recaptured. Moth collections were made in two fields, which were about 1 mile apart, and in random cuts between the fields. No moths that had been marked were recaptured, probably owing to the small number that were marked and to the relatively small acreage on which the trap could be operated. Both male and female moths were carefully observed in the field during the

[1]In cooperation with the Bureau of Entomology, United States Department of Agriculture.

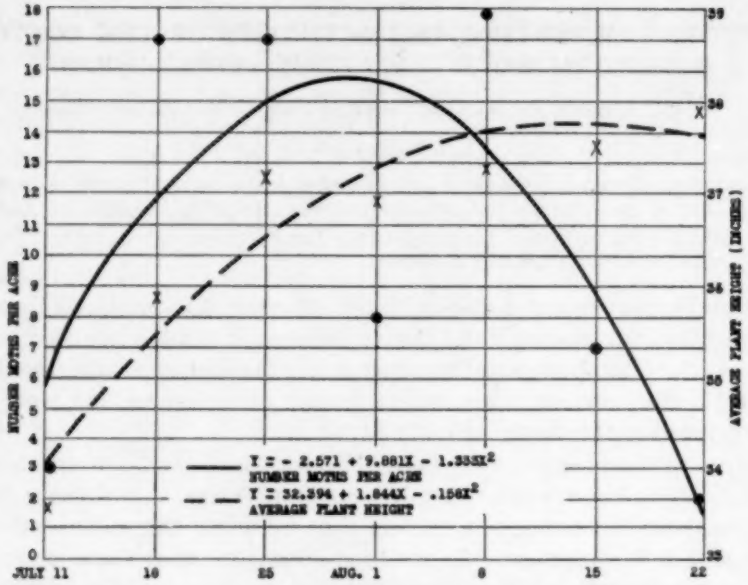

Fig. 71.—Parabolic curves showing the average moth catch and the average plant heights during the period from July 11 to August 22 in the field of rank cotton.

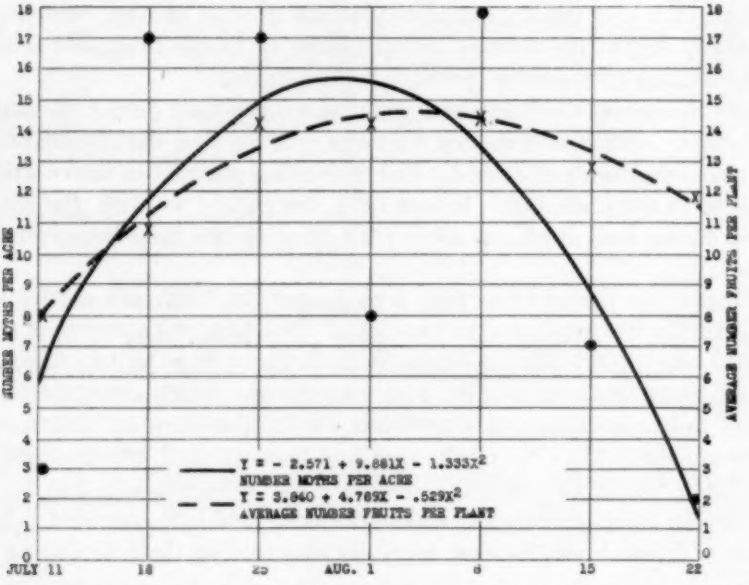
NUMBER MOTHS PER ACRE
AVERAGE NUMBER FRUITS PER PLANT
Y = - 2.571 + 9.861X - 1.333X²
NUMBER MOTHS PER ACRE
Y = 3.840 + 4.769X - .529X²
AVERAGE NUMBER FRUITS PER PLANT
JULY 11
AUG. 1
22

Fig. 72.—Parabolic curves showing the average moth catch and the average fruit per plant during the period from July 11 to August 22 in the field of rank cotton.

time the first generation was in the cotton. The moths rested during the day in secluded places on the cotton plant, the only movement being occasional crawling over the plant to places that afforded better protection from the sun. Moth activities began just at dusk and ceased about daylight. During the periods that the moths were active they flew from plant to plant feeding and ovipositing, sometimes flying as far

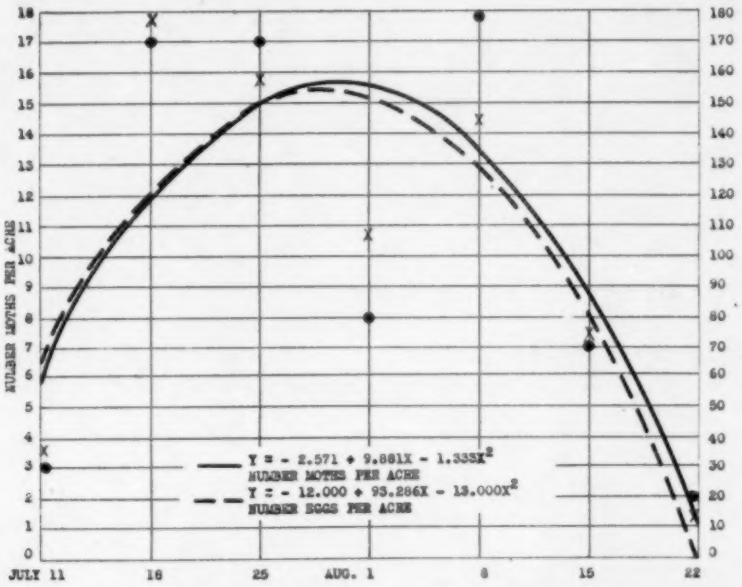

Fig. 73.—Parabolic curves showing the average moth catch and the average number eggs per acre during the period from July 11 to August 22 in the field of rank cotton.

as 100 yards or more in one flight. These observations indicate that the moths, during the active period, visit a large number of cotton plants and may travel quite a distance. Determinations of the moth catch during the entire season showed that the sexes were about equally divided, although the males were slightly in the majority. During the first week of each generation, however, there were about twice as many males as females.

In order to determine the relation between the growth of cotton, the number of fruits per plant (squares, bloom, and bolls), the moth population, and egg deposition, the cart type of trap was operated three times a week on 1 acre of small and 1 acre of rank cotton. The catch, or number of moths, was averaged for the week, and the growth of the cotton,

the number of fruits per plant, and the number of eggs per acre were recorded at weekly intervals. The data for both fields are presented in Table 1.

TABLE 1. RECORDS OF PLANT HEIGHTS, FRUIT, MOTHS, AND EGGS IN RANK AND SMALL COTTON

Seven-day period ended— 1932	Average plant height		Average fruits per plant		Moths caught per acre*		Average eggs per acre	
	Rank	Small	Rank	Small	Rank	Small	Rank	Small
	Inches	*Inches*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
July 4....	——	27.19	——	11.97	—	3	—	0
July 11...	33.66	29.25	8.03	12.66	3	5	36	19
July 18...	35.80	28.91	10.92	9.89	17	12	180	26
July 25...	37.20	28.59	14.38	8.20	17	4	156	39
Aug. 1....	36.91	28.23	14.30	6.06	8	1	108	0
Aug. 8....	37.25	28.24	14.46	5.13	18	2	144	0
Aug. 15...	37.54	——	12.95	——	7	—	72	—
Aug. 22...	37.88	——	11.82	——	2	—	12	—

*Average of three collections.

From the data in this table it is seen that the cotton in the field designated as rank grew faster and over a longer period than that in the field designated as small. Unless there is a significant increase in the plant heights, it is said that no growth takes place. Many more moths were

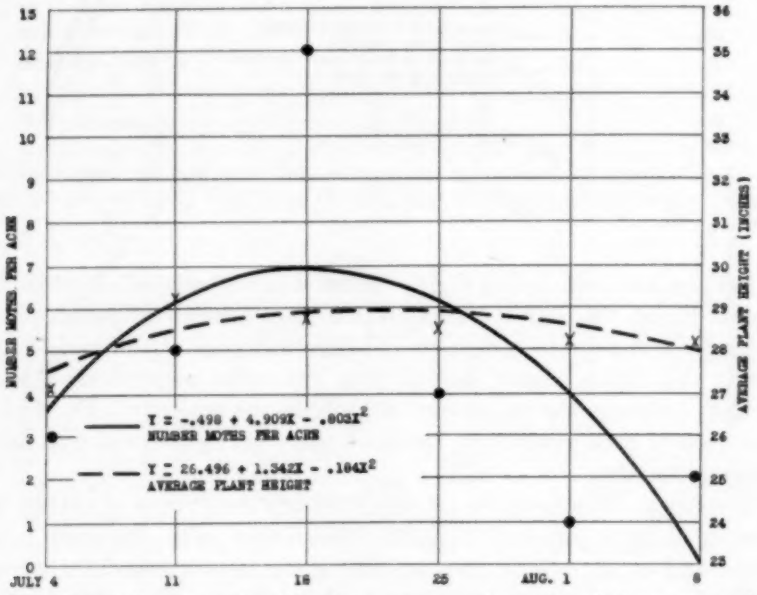

Fig. 74.—Parabolic curves showing the average moth catch and the average plant heights during the period from July 4 to August 8 in the field of small cotton

captured, more eggs were deposited, and more fruit was produced in the rank cotton than in the small cotton. It will also be noted that in both fields, after the cotton began to deteriorate, the number of moths and the number of eggs were considerably lower. This occurred in the field of small cotton about July 25, but in the field of rank cotton not until about August 15.

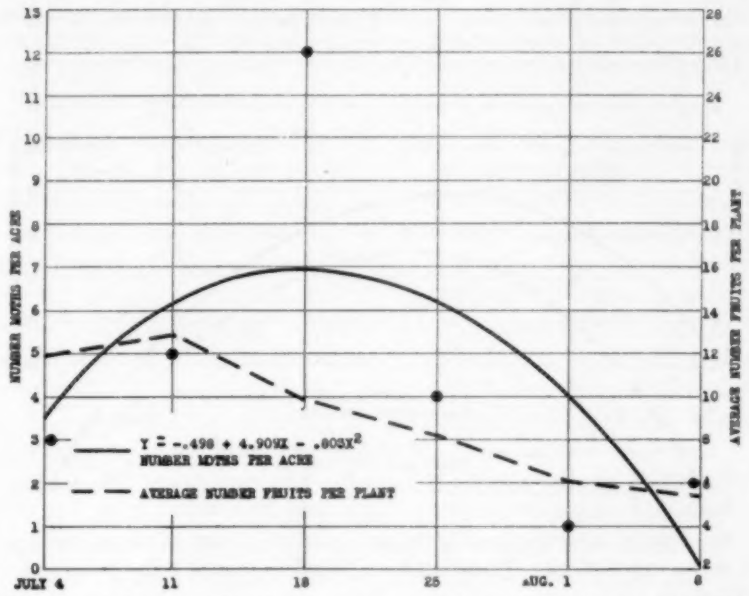

Fig. 75.—Parabolic curve showing the average moth catch and the average fruit per plant during the period from July 4 to August 8 in the field of small cotton.

For each of the factors plant height, fruit, eggs, and moth catch a curve, which is a second-degree parabola, has been fitted by the method of least squares (*2*). In each case, (Figs. 71 to 76), the equation for the curve is given. These curves show the trend for each variable during the period of time in which two generations of bollworm moths occurred in the cotton.

In the field of rank cotton, during the 7-day period ended August 8, the moth catch had begun to decrease, and the cotton had practically stopped growing (Fig. 71), had stopped fruiting (Fig. 72), and the average number of eggs had begun to decrease (Fig. 73). In the field of small cotton, however, these phenomena occurred during the 7-day period ended July 25 (Figs. 74, 75, and 76, respectively.).

During this season, when the moth population was low and all the moths were probably of local origin, there was a close association between the average plant heights, the number of fruits per plant, the average moth catch, and the average number of eggs per acre. At

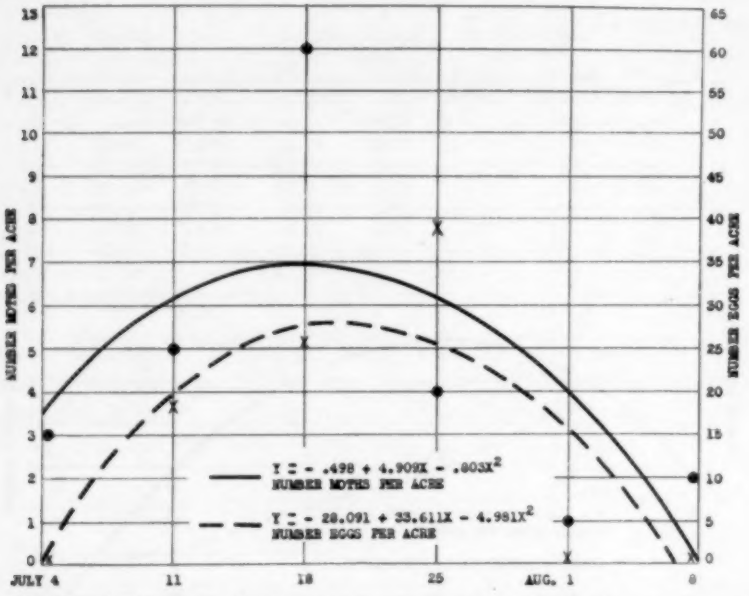

Fig. 76.—Parabolic curves showing the average moth catch and the average number of eggs per acre during the period from July 4 to August 8 in the field of small cotton.

the time the cotton stopped growing, as indicated by the plant height and fruiting, the moth and egg populations began to decrease in the fields of rank cotton and also in those of small cotton. The "spotted" infestations that occur every year are due to the rapid growing and fruiting of the cotton plants, which are factors that tend to increase the moth and egg populations.

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A STUDY OF THE COTTON FLEA HOPPER WITH SPECIAL REFERENCE TO THE SPRING EMERGENCE, DISPERSAL, AND POPULATION

By J. C. GAINES, *Entomologist, Texas Agricultural Experiment Station*

ABSTRACT

The population of the cotton flea hopper, *Psallus seriatus* (Reut.), is increased by rainfall which produces a rapid growth of the host plants. Early fall rains which promote the growth of fall weeds are influential in determining the number of insects that emerge the following spring. Time of spring emergence and dispersal are factors that influence the population in cotton.

The cotton flea hopper, *Psallus seriatus* (Reut.), like many other insects, has rather definite periods during the year when it transfers from one host to another. Early in the season the insects migrate from the weed fields and are disseminated in cotton. Later, usually during July or August, the insects leave cotton and migrate to goatweed fields where the greater portion of eggs are deposited and remain overwinter. The fact that in a given year cotton is heavily infested with flea hoppers in some localities and not in others and the fact that the localities in which cotton was heavily infested one year but may not be infested the next have given rise to considerable speculation as to the cause of these conditions.

The present paper summarizes the results of three years' observations, 1930, 1931, and 1932, in the vicinity of College Station, Texas. This phase of the cotton flea hopper problem deals with the various factors that affect the population or the number of insects that develop and cause injury to cotton.

The emergence or the number of flea hoppers hatching in the spring was obtained by gathering 100 goatweeds (*Croton capitatus*) from each of several selected fields and placing them in cages about February 1, or before the overwintering eggs begin to hatch. The cages are wooden frames, constructed of 1″ x 4″ material and measure 2′x 2′ x 3′. The sides and top are covered with black percale with a series of 28 vials inserted around the top and halfway down one edge on each side. The light which comes through these vials serves to attract the young insects as they hatch from the weeds. The flea hoppers were taken out of these vials daily during the spring and the numbers recorded.

To determine when cotton flea hoppers were actually flying, a series of traps (Fig. 77) was set up in both cotton and goatweed fields. Each trap was made by tacking a piece of ordinary screen wire to a 5′ x 3′ frame, constructed of 1″ x 2″ material. The ends of two of these frames were

nailed together and also to three posts placed in the ground in triangular arrangement, the two frames forming a right angle with the bottom edge about three feet above the ground. The wire was coated at regular intervals throughout the year with a sticky tree-banding preparation. These traps were visited at least every two days and, when possible, every day; the cotton flea hoppers were removed and the number recorded.

Fig. 77.—Standard type of trap used to capture cotton flea hoppers.

The population records were obtained by making 100 sweeps with a 16″ diameter insect net, and the number of adult cotton flea hoppers was recorded. These records were made at weekly intervals in both the goatweed and the cotton fields from early spring until late fall. A minimum of 20 adult cotton flea hoppers per 100 sweeps is considered as being sufficient to cause injury to cotton.

Dispersal and Population in 1930.—Sixteen screen traps (Fig. 77) were located in cotton fields during the season of 1930. It was found that the dispersal and population were greater in some fields than in others, but the time of dispersal was about the same in all the fields. Therefore the data have been summarized and are discussed accordingly.

The screen traps were set up in July after the spring migration had taken place. The first period in which the trap catch was high occurred between July 15 and August 15. This period occurred just after the population in cotton had reached its maximum. (Table 1.) Following this and until about the middle of September, a light, general movement was noted which was indicated by the trap catches. Then another period began in which the catch was high and lasted until about the middle of October, during which time the flea hopper population was high in goatweeds. (Table 1.) Apparently this fall activity was due to the insects flying about in search of a desirable location to oviposit.

TABLE 1. RECORDS OF THE NUMBER OF ADULT COTTON FLEA HOPPERS PER 100 SWEEPS IN COTTON AND GOATWEEDS IN 1930

	July 16	July 31	Aug. 12	Aug. 28	Sept. 8	Sept. 26	Oct. 3	Oct. 10	Oct. 17
Adults per 100 sweeps in cotton*	8	11	1	0	0	0	0	0	0
Adults per 100 sweeps in goatweeds*	—	—	—	—	—	986	1,585	288	60

*Average of 16 fields of cotton and 3 fields of goatweeds.

During the period from July 12 to November 15, 1930, the average weekly maximum temperature varied from 68° to 102° F., while two distinct periods occurred when the catch was high on the traps. The correlation coefficient between the daily maximum temperature and the daily trap catch was .196 ± .057, which indicates that the correlation between these two variables is barely significant. Temperature seems to be an unimportant factor on the dispersal of the cotton flea hopper since there were days on which the trap catch was low and the temperature was low and other days on which the trap catch was low and the temperature was high.

After analyzing the data it was found that there were days between July 12 and November 15 when the humidity was low and the trap catch was low, and there were days when the humidity was high and the trap catch was low. The correlation coefficient between the daily minimum relative humidity and the daily trap catch is — .073 ± .059. This insignificant correlation coefficient and a comparison of the data representing the two variables indicate that minimum relative humidity was also an unimportant factor on the flea hopper dispersal.

Rainfall seemed to be an important factor influencing the population in both cotton and goatweeds. During June, July, and August the rainfall was below normal, causing the cotton to stop growing, and the flea hopper population decreased. During September and October the rainfall was above normal, causing the goatweeds to grow rapidly, affording an ideal place for the flea hoppers to feed and breed, and the population increased to high numbers. (Table 1.)

EMERGENCE, DISPERSAL, AND POPULATION IN 1931.—Cotton on black land sections of Texas, on which goatweeds (*Croton capitatus*) do not grow, and which are from 10 to 25 miles from fields of goatweeds, become heavily infested with flea hoppers in the early spring practically every year. Since goatweed is the principal host for the flea hopper to deposit eggs that overwinter, it was deemed advisable to determine the distance at which a goatweed field would influence the spring population of flea hoppers in cotton. A desirable location was found in the Brazos

River Bottoms, Burleson county, Texas, where a section of level bottom land about four miles wide and principally planted to cotton, bordered a goatweed field several miles in length on the south side. Screen traps were located in this strip of goatweeds and extended northward in the cotton at one-eighth, one-fourth, one-half, three-fourths, and one and one-fourth miles from goatweed fields.

The first adult flea hopper was captured on the trap located one and one-fourth miles from goatweeds on April 14, before the cotton had been planted. There was no significant difference between the catch on any of the traps or the population in the different cotton fields. From these data, it is evident that in this case the flea hopper population in cotton was not affected by being in close proximity to goatweeds.

Since there was little difference in the time of dispersal as indicated by the trap catches at the different locations, the data have been summarized and are discussed accordingly for both cotton and goatweeds.

It will be noted that the 1930 fall flea hopper population in goatweeds was high during the latter part of September and October. (Table 1.) The average number of insects that hatched during the spring of 1931 from 100 of these goatweeds was also fairly high. (Table 2.) About 94 per cent of the insects hatched during March and April, or before cotton was up to a stand. This condition caused a large number of the young insects to die early in the season in the event they were disseminated by wind from the weed fields to cotton fields. A small number of early-hatched nymphs matured and was flying through the cotton fields by April 14. Due to the small number of insects that could survive the early temperatures and transfer to cotton from the weed fields, the population was slow in developing.

TABLE 2. THE AVERAGE NUMBER OF COTTON FLEA HOPPER NYMPHS THAT EMERGED FROM 100 GOATWEEDS

1931	March	April	May	Total
Number of nymphs that emerged from 100 goatweeds*	2,326	1,666	241	4,233
Per cent emerged	54.94	39.36	5.70	100.00

*Taken from the same fields in which sweeping records were made the previous fall.

The curves showing the average weekly catch on the traps and the population in both goatweeds and cotton are shown in Figures 78 and 79, respectively. It will be noted that a general high peak of catch occurred in cotton during May and June. The insects increased in numbers in the weed fields on miscellaneous weeds, including horsemint (*Monarda* spp.), until about June 8 when the population decreased in the weed fields and increased in cotton. A high peak of catch was recorded

on the traps located in the weed fields about the middle of June, or about the time the flea hoppers transferred from the weeds to cotton. Another small peak of catch occurred on the traps in both cotton and

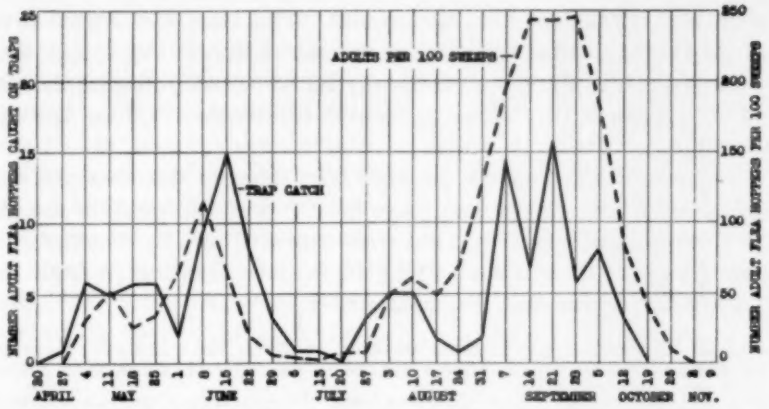

Fig. 78.—Number of cotton flea hoppers captured on two traps and the average number adult flea hoppers per 100 sweeps in the two fields of goatweeds around each trap in 1931.

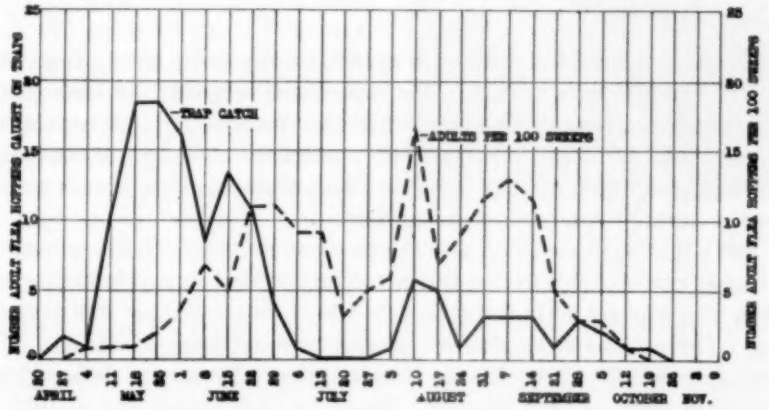

Fig. 79.—Number of cotton flea hoppers captured on seven traps and the average number adult flea hoppers per 100 sweeps in the seven cotton fields around each trap in 1931.

goatweeds about the time the population again increased in cotton and in goatweeds. A general high peak of catch occurred on the traps located in goatweed fields during September and October, or when the insect population was high in goatweeds. Due to late-planted cotton in two

of the fields, a few of the insects remained in the cotton until late in the season.

One trap was set up with the bottom edge six feet from the ground in the same field in which a standard trap was located which had the bottom edge three feet from the ground. This trap was located to determine at what altitude the largest number of insects was flying. Since the catch on these traps was practically the same except during the early part of the season, the difference in catch will be discussed for April and May only.

The catch was higher on the high trap than on the standard trap. (Table 3.) About 83 per cent more insects were captured on the high trap during April and May than were captured on the standard trap. Apparently the insects were flying high and migrating in from long distances during this early dispersal period.

TABLE 3. RECORDS OF THE NUMBER OF ADULT COTTON FLEA HOPPERS CAPTURED ON A HIGH TRAP COMPARED WITH A STANDARD TRAP CATCH IN THE SAME FIELD

Date 1931	Bottom edge of trap three feet from ground* Number adults captured	Bottom edge of trap six feet from ground Number adults captured
April.....	2	39
May.....	74	100
Total...	76	139

*Standard Trap.

The recorded rainfall was below normal during every month from May to October, inclusive. This factor caused a slow growth in both cotton and goatweeds, and the flea hoppers did not increase to large numbers in either. The flea hopper population was much lower in the goatweeds during the fall of 1931 than it was in 1930, when much more rain was recorded during September and October.

EMERGENCE, DISPERSAL, AND POPULATION IN 1932.—Three traps were set up in cotton fields during the latter part of March, and later on, June 15, a trap was set up in a cotton field where an infestation was developing. Three traps were also set up in goatweed fields in March. The average catch for these traps is discussed since the time of dispersal was about the same at each location. Since the high screen trap in 1931 indicated that the insects were flying high at certain periods of the year, a tall trap was set up in a cotton field during 1932. (Fig. 80.) This trap was made on the same principle as the standard trap but extended into the air 25 feet with the wings only 3 feet wide.

The flea hopper population was considerably lower in the goatweeds during the fall of 1931 than in 1930, and the spring emergence from the weeds was lower in 1932 than in 1931. (Table 4.) The fall flea hopper

population in goatweeds is an important factor in determining the number of nymphs that hatch in the spring. The time and the number of nymphs that hatch are factors that help to determine the extent of injury that may occur in cotton. In the spring of 1932 over 16 per cent of the nymphs hatched during May after cotton was up to a stand and there was an abundance of weeds and seedling cotton in which the insects could develop. A few early-hatched nymphs matured and were flying through the fields by April 8.

The curves representing the average weekly catch on the traps and the population in both goat weeds and cotton are shown in Figures 81 and 82, respectively. A general movement, as indicated by the trap catches, was noticeable in the cotton early in the season. The fact that there was very little horsemint present and that there was no peak in the insect population of the weeds early in the spring probably accounts for there not

Fig. 80.—Tall trap used to capture cotton flea hoppers.

TABLE 4. RECORDS OF THE 1931 FALL COTTON FLEA HOPPER POPULATION AND THE 1932 SPRING EMERGENCE FROM GOATWEEDS.

Date 1931	Number adults per 100 sweeps in goatweeds	Date 1932	Number nymphs that emerged from 100 goatweeds*	Per cent emerged
Sept. 11	199	March	1045	59.31
Sept. 18	242	April	424	24.07
Sept. 25	239	May	293	16.62
Oct. 2	243	Total	1,762	100.00
Oct. 9	178			
Oct. 16	85			
Oct. 23	40			
Oct. 30	12			

*Taken from the same fields in which the sweeping records were made the previous fall.

being a higher peak of catch on the traps during this early spring period. Another and a much higher peak of catch occurred on the traps in the cotton during July and the first half of August, at which time the

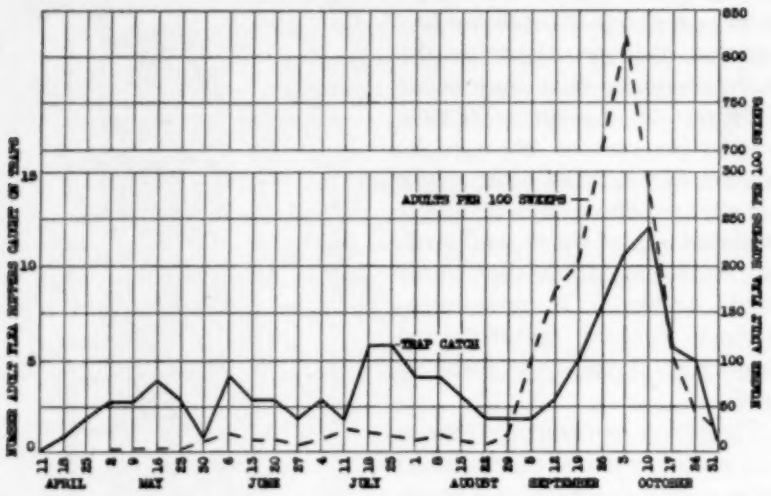

Fig. 81.—Number of cotton flea hoppers captured on three traps and the average number adult flea hoppers per 100 sweeps in the three goatweed fields around each trap in 1932.

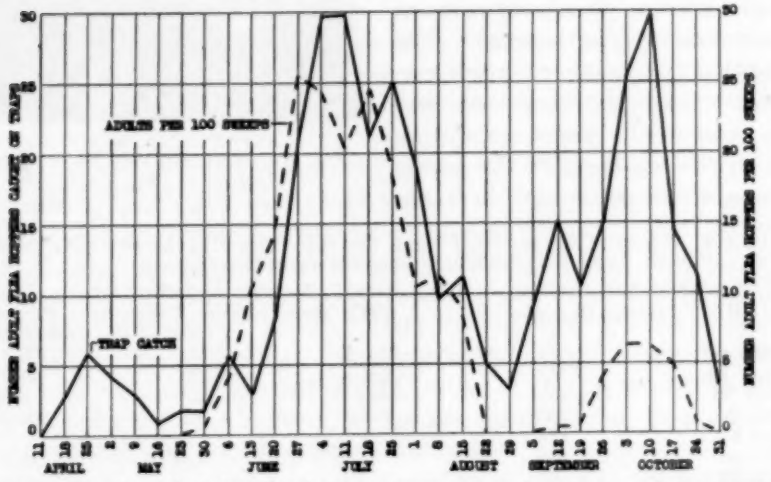

Fig. 82.—Number of cotton flea hoppers captured on five traps and the average number adult flea hoppers per 100 sweeps in the five cotton fields around each trap in 1932.

population was high, causing severe injury to cotton. A peak of catch also occurred on the traps in the goatweed fields during July and the first half of August which indicates that the transfer from cotton to goatweeds occurred about this time. High peaks of catch occurred in both cotton and goatweed fields during September and October at which time the population was high in goatweeds and in some cotton fields. The trap catches indicate the time that the flea hoppers transfer from one crop to another and also indicate to some extent the abundance of insects that are in the fields.

The catch on the portion of the tall trap corresponding to the same altitude on the high trap used in 1931 was not consistent, probably due to the different type of trap that was used in 1932. The high trap used in 1931 was only 9 feet high with free circulation of air around the 3′ x 5′ trap area, while the tall trap used in 1932 was a continuous trap area from 2′ to 20′ in height. However, the trap area from 21′ to 25′ did have free circulation of air and is comparable to the catch on the bottom portion of the trap. About 10 times as many adult flea hoppers were captured on the portion of the trap from 21′ to 25′ from the ground as were captured on the portion of the trap from 2′ to 6′ from the ground during April and May. The catch seemed to be about the same at the different altitudes during the summer months but was considerably higher on the highest portion of the trap during October. This indicates that the adults fly high and spread over long distances during these two dispersal periods.

Practically a normal rainfall was recorded during the spring which caused the cotton to grow rapidly during June and the first half of July. The cotton stopped growing early in August on account of insufficient moisture, and the flea hopper population decreased. Excessive rains during September caused the goatweeds to start growing, and the population of this insect increased rapidly during the latter part of September and the first week in October. These early fall rains caused the flea hopper population to be much higher in goatweeds during the fall of 1932 than in the fall of 1931 when the rainfall was below normal and were similar to the fall rains of 1930, which also caused a large increase in the number of flea hoppers.

SUGARCANE BORER EFFECT UPON VALUE OF SEED CANE

A Preliminary Report

By W. E. HINDS, *Entomologist* and B. A. OSTERBERGER, *Assistant Entomologist*, *Louisiana Experiment Station*

ABSTRACT

During recent years especially, leaders in sugarcane borer control investigations have strongly advocated the utilization of seed stock which is as free from borer infestation as it is possible to secure. However, no actual studies measuring the effects of borer infestation in seed cane upon the resulting stands and yields during the following season had been made until 1928–1929. At this time a plantation field test was made with POJ. 213 cane, including three acres or more in each area, and using practically borer free seed in one field and all lightly infested seed cane in the other field. The following August there was found to be a decrease amounting to approximately 14% in the number of canes per 1000 row-feet. There was an excess amounting to 13.5% in the unoccupied ground or "skips" included in excess of three feet along the rows. At harvest time the lightly infested seed field averaged 9% less in weight of cane, or approximately three tons per acre less yield than in the borer free seed field.

In 1931–1932 six varieties of cane were tested in a very detailed and accurate way at the Louisiana Sugar Experiment Station. Seed of each variety was selected for three classes of infestation, representing (1) practically borer "free," as based upon evidence of borer burrows in the cane, (2) "light" or "medium" infestation and (3) "heavy" infestation. Before the cane was covered, a close examination was made to determine the condition of eyes, the number of eyes planted, borer burrows, emergence holes, etc., in each plat. Replicated plats of 50 feet were used and the cane was planted single stalk and butt to tip. The rate of seed per acre required on this basis ranged from 1837 pounds with longest jointed, most slender type of cane, to 3240 pounds with the shortest jointed, heaviest stalks. The winter was exceedingly mild with no killing frost until March 6, 1932. In February there was a very evident decrease in germination or retardation in germination in the more heavily infested plats as compared with the borer free seed plats. There was a consistent trend in the direction of increase in "skips" (in this case taken as the excess above 18 inches space between stools) as infestation in the seed increased, and a correlating decrease in the number and total weight of millable stalks produced. The loss in yield, as computed

from the plat to the per-acre basis, showed a loss ranging up to 8.5 tons per acre with the most susceptible variety. The more vigorous growing types of cane suffered less than those of medium-vigorous growth, but in all groups it is very evident that the increase of borer infestation in seed cane produces an important loss in following yields. The average loss in three varieties of medium vigorous growth was 17.5%, or over 4 tons per acre. With the three varieties of more vigorous growth the loss amounted to practically 2½ tons, or an average of 7.1% of the yield secured in the borer free plats of the same varieties.

SUGARCANE BEETLE INJURY TO GREENHOUSE ROSES

By CLAY LYLE, *Entomologist, State College, Miss.*

Serious injury to greenhouse roses by adults of the sugar cane beetle or rough-headed corn stalk-beetle, *Euetheola rugiceps*, was observed at Columbus, Mississippi, the first week in September, 1932. Apparently the time of greatest damage was three or four weeks earlier as most of the beetles had disappeared when the injury was discovered. About 12,000 roses were in the greenhouse; and from sample counts, it was evident that about 67% of the plants had been attacked. All of the injury was of the same type, the bark having been gnawed just below the soil surface. Some plants were almost cut in two. When the injury was noticed, callouses were already forming, and many of the plants eventually recovered.

This unusual injury in greenhouses apparently resulted from filling the benches with soil from a nearby pasture in June, at which time the beetles were in the egg or a very small larval stage and escaped notice. The soil was taken from a strip along a small ditch through a pasture which was thickly sodded with various grasses. Although this is the first case of this kind noticed, nursery inspectors may find it advisable to caution greenhouse operators about the localities from which they select soil for filling benches, since heavy loss may occur in a single instance such as the one reported here.

A METHOD OF AVOIDING THE DESTRUCTION OF TRICHOGRAMMA IN SUGARCANE FIELDS

By T. E. HOLLOWAY, *Bureau of Entomology, U. S. Department of Agriculture*

ABSTRACT

Attention is called to experiments started twenty years ago on the conservation of sugarcane "trash" as a method of avoiding the destruction of Trichogramma. Bacteriologists and others now find that the incorporation of the trash in the soil is desirable.

We hear much nowadays of the breeding and release of the parasite *Trichogramma minutum* Riley, which is a common and widely distributed parasite of the eggs of the sugarcane borer (*Diatraea saccharalis* Fab.) and of many other insects. The wholesale destruction of this beneficial insect by the burning of the "trash" or dead leaves left on the sugarcane fields after harvest is to be deplored as a waste.

The sugarcane plant is plentifully supplied with leaves, which are cut off and left on the fields when the cane is cut and hauled to the mill. At the time of harvest Trichogramma is naturally present in large numbers in nearly every field. No one knows just how or where it hibernates in the Louisiana cane fields, but it is believed to be a weak flier, and we can hardly suppose that it flies out of the fields when cold weather commences. Why should it? The low temperatures would induce inactivity and tend to prevent flying, and the parasite would not need to seek other hibernation quarters when they are present in abundance in the masses of leaves left on the fields.

The universal practice on sugar plantations, however, has been to burn over the fields as soon as possible. It was once thought that this would destroy the larvae of the sugarcane borer, but it is now known that the borers are safe in their tunnels in stubble cane, planted cane, coarse grasses, and juicy scraps of cane. The fires run over the fields quickly, consuming the covering of leaves but leaving the borers in the canes unharmed.

Of course, the borers contained in the scraps of cane which are left on the field can be killed. With infinite pains the scraps can be collected and destroyed. But this is never done, at least on real sugar plantations by plantation people.

Trichogramma minutum was found to be a parasite of the sugarcane borer in Louisiana in 1912, and in the same year the writer (*1*) suggested that experiments in natural control be initiated by preserving the trash from burning in an attempt to avoid destroying its content of parasites. These experiments were followed by similar tests over a period of a good many years. They have been fully reported in sugar

journals and Government bulletins (*2, 3, 4, 5, 6*). It was found that the non-burning of cane trash gave good results where it was carried out over a whole plantation. Even where adopted on a small scale it probably preserved many parasites, but the results in lessened damage from the borer thus obtained were not usually apparent owing, doubtless, to the flight from field to field of both borer moths and parasites. The criterion of the success of these experiments was not in reduced borer population or increase in parasite population, but in the actual lessened damage to the sugarcane where large areas were left unburned.[1]

As the experiments previously referred to are recorded in the literature it is unnecessary to mention them further, but some of our results have been favorably quoted by A. D. Imms, of the Rothamsted Experimental Station, in his lately published book, "Recent Advances in Entomology," (*7, p. 352*). In this he reprints our table showing that in a season when the loss due to the borer was 13 per cent at the Audubon Park Experiment Station, where trash was not burned, it was 30 per cent over the State, with similar results for other years.

While the entomology of the non-burning of trash was worked out years ago, it was not until rather recently that the other phases of the subject were investigated. The incorporation of cane trash with the soil has now been studied by bacteriologists and agronomists, all of whom report favorably on this practice.

Owen and Denson (*8*), bacteriologists of the Louisiana Experiment Station, conclude, "The fact that field experiments over a period of several years at this station have shown no decrease in crop yields from the practice of turning under cane trash it would appear that the nitrate nitrogen immobilized by the presence of the organic matter is in excess of the immediate requirements of the growing crop. This would make the practice of turning under trash consistent with the necessity of conserving the surplus available nitrogen in the soil."

Sturgis (*9*), also of the Louisiana Experiment Station, writes, "By the

[1]In some countries where the value of this practice of not burning trash has been shown, by work similar to that done in Louisiana, the conservation of trash has been widely adopted. Almost everywhere in Puerto Rico that ratoon cane is grown, fields with the trash lined in alternate rows are the rule. (Where the trash is burned, this is only to clear the land for plowing in preparation for planting.) The cost of raking the trash into alternate rows averages about 75c per acre, but on the other hand, cultivation expenses are halved. Even in sections where irrigation is practiced, the trash in alternate rows presents no insuperable problem, for only the alternating cultivated rows are irrigated. Primarily adopted to favor *Trichogramma* and reduce *Diatraea* injury, this practice has now become general in Puerto Rico. (*Footnote contributed by Dr. Geo. N. Wolcott, Insular Experiment Station, Rio Piedras, P. R.*)

addition of inorganic nitrogen with the cane trash at the rate of 5 pounds of nitrogen per ton of fresh field trash and the incorporation of the mixture within the surface 5 inches of soil, the rate of decomposition will be increased and the presence of available soil nitrogen insured. Since the nitrate nitrogen disappears from the surface soil during the winter and spring, an early application of the trash alone with the supplemental nitrogen being added in the spring directly ahead of the crop would prove the more practical method for the use of trash.

"The application of cane trash to the soil increased the soil nitrogen and organic matter. The gain in the soil nitrogen from the use of trash was, within the limit of experimental error, equivalent to the nitrogen content of the trash.

"The resultant decomposition following the application of trash increased the availability of phosphorus 15 to 20 pounds per acre during the earlier stages of decomposition."

Frankly speaking, the sugar planters of Louisiana have not adopted our recommendation to preserve the cane trash. Agronomists and bacteriologists have now come to our aid, as shown in the quotations just presented. It may be that we will have to call in the services of inventors and machinists to produce a machine which will shred or chop the trash so that it will give no trouble in cultivation. So far as I know, the sugar planters have never doubted that non-burning results is at least a partial control of the borer, as we claim. They have objected to it on account of the trouble the trash may cause in subsequent cultivation. However, there is a new interest in the subject, and it seems doubtful whether cane growers can much longer afford wastefully to burn up so much material of fertilizing value as well as so many beneficial insects.

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Aphis Lion Predators of the Potato Psyllid. Aphis lions have been observed to destroy psyllid nymphs under field conditions. A half-grown aphis lion (*Chrysopa* sp.) was placed in a 3-dram homeopathic vial with 14 adult potato psyllids, *Paratrioza cockerelli* (Sulc). The aphis lion immediately seized a psyllid and fed upon it for 13 minutes. Four minutes later a second psyllid was captured, the mandibles being first sunk ventrally into the body, one into the thorax and the other into the abdomen. The position of the mandibles was shifted several times during the course of feeding, the front tarsi sometimes being used to shift the prey. Feeding lasted for two minutes. Another psyllid was captured two minutes later and fed upon for nine minutes. The next psyllid was captured in less than one minute, its dead body being discarded at the end of four minutes of feeding. Two minutes later another psyllid was captured. During the nine minutes of feeding the aphis lion frequently changed the position of its mandibles, leaving the psyllid in a very much mangled condition. This predator killed and sucked the fluids from five *P. cockerelli* adults in 46 minutes. Another aphis lion was placed in a 3-dram vial with a number of *P. cockerelli* nymphs; within 35 minutes nine nymphs had been killed, the feeding interval upon each being 2, 2, 1, 2, 4, 1, 2, ½, and ½ minutes to each one, respectively.

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Beech injured by borers. The beech limb borer (*Xylotrechus quadrimaculatus* Hald.) has been attracting notice the past few years, though previously it was a somewhat unknown insect. It has come to attention through its boring in and pruning off limbs of beech at Wenham, Mass., New Canaan and Greenwich, Conn. The infested limbs are often two inches in diameter and are cut off in much the same way as by the rather common oak and maple twig pruner. This insect appears to be local in habit, and in the course of a few years may become sufficiently abundant as to seriously mutilate good sized trees. The eggs, according to the observations of Messrs. Champlain, Kirk and Knull, are laid in crevices of the bark, and in healed over injuries in the branches, from the last week in May to the middle of June. The borers winter in the branches, consequently systematic pruning and burning is a promising control.

The two-lined chestnut borer (*Agrilus bilineatus* Web.) or a closely related species, has been observed working in beech limbs at Greenwich, Conn., in the vicinity of Westbury, L. I., and at Wilmington, Del., killing individual branches and marring the symmetry of the tree. In one instance a sickly European hornbeam showed transverse ridges at the base of the larger branches, produced probably by this species, and a number of the smaller branches were in a dead or dying condition.

E. P. FELT

EXPERIMENTS IN THE CONTROL OF THE CORN EARWORM, *HELIOTHIS OBSOLETA* (FABR.), WITH *TRICHOGRAMMA MINUTUM* RILEY

By ROBERT K. FLETCHER, *Texas Agricultural Experiment Station*

ABSTRACT

Studies in the dispersion of *Trichogramma minutum* in cornfields and two experiments in the control of the corn earworm with *Trichogramma minutum* are described.

The serious damage done by *Heliothis obsoleta* to corn is well known. As a concrete illustration, in seven fields under observation near College Station, Texas, in 1931, an average of 95 per cent of the ears were injured. It is not unusual in making examinations late in summer to find 100 per cent of the ears at a point damaged. The eggs of the corn earworm, especially those laid upon the silks, are frequently found to be parasitized by *Trichogramma minutum*. This parasitism tends to increase as the season advances; 50 per cent of the eggs deposited on the silks of late corn are often parasitized. This suggests the possibility of using Trichogramma for the control of the earworm. It was with this idea that the following experiments were made.

In 1931 several attempts were made to determine the amount of spread of Trichogramma from certain points of release. All of these releases were made in field corn in the silking stage. Angoumois grain moth eggs parasitized by Trichogramma were placed in gelatin capsules which were pinned to the underside of a corn leaf in such a manner that the parasites could escape as they hatched. Care was taken to place the capsules adjacent to a silk bearing earworm eggs. Each capsule contained 100 or more parasitized grain moth eggs. Earworm oviposition records were taken at each point of release and the amount of egg parasitism recorded. Checks were selected at varying distances and the same records taken. During the season similar Trichogramma releases were made at 140 points in corn by distributing one capsule at each point. No increase in egg parasitism was found at any point. This was probably because the number of parasites released at each point was not great enough. Considerable trouble was experienced with the capsules collapsing because of heat and moisture. Grasshoppers were observed gnawing holes in the capsules although it was not determined whether or not they ate the parasitized eggs. Lady beetles and the predacious bug, *Orius insidiosus* (Say), however, entered through these holes and were observed to feed on the eggs. In a majority of cases, however, the Trichogramma succeeded in emerging successfully.

In 1932, two experiments were carried out with the definite idea of controlling the corn earworm with *Trichogramma minutum*, if possible. The first of these experiments was undertaken in sweet corn on the Central State Farm at Sugarland, Texas. The Trichogramma for this experiment were secured from Dr. A. W. Morrill, Los Angeles, California. They were of the Louisiana strain. The parasitized grain moth eggs were shipped from Los Angeles by airplane, shipments being arranged so that the parasites would begin to emerge a few hours after arriving. As soon as emergence was well underway, they were placed in an electric refrigerator and kept at a temperature between 38° and 40° F. They were kept at this temperature for 36 hours in one case with no effect on subsequent emergence nor any increase in number of males. A few hours before the parasites were to be released in the cornfields, they were removed from the refrigerator and emergence allowed to continue. The Trichogramma were shipped in capsules, at least 500 parasitized Angoumois grain moth eggs in each capsule. Several cards of eggs from which parasites had emerged were examined, and about 98 per cent of the eggs had each produced a parasite.

Five plots of one acre each were selected at the west end of the above field of sweet corn in which to release Trichogramma. Three plots adjoining these on the east were selected as checks. Earworm oviposition on corn silks is continuous from the time the first silks appear until only dry silks are left in the field. It was decided, therefore, to release Trichogramma at intervals of a few days. It was thought that it might be possible thus to insure the parasitism of the first eggs laid and to build up a high rate of egg parasitism in the field. The first Trichogramma were released the day following the first appearance of silks. Two thousand Trichogramma were released in each of the five plots on the following dates: May 23, May 27, and June 3, a total of 6,000 parasites per acre. The parasites were released by removing the end of the capsule and walking back and forth across each acre, holding the capsule with the open end up in the hand. By watching carefully, it was possible to see the Trichogramma take flight and to so gauge the rate of walking that an even distribution throughout the field would be secured. Releases were made at approximately 8 o'clock in the morning.

At each Trichogramma release oviposition records were taken, and the per cent of egg parasitism as shown by black eggs was determined. In making egg counts, only the silks, ears, and leaves and stalks adjoining the ears were examined. Records were also taken of the number of fresh silks and the number of dry silks per 100 stalks. After fresh silks appear in the corn, very few eggs are found on the stalks. The records sum-

marized in Table 1 indicate the distribution of eggs and egg parasitism in the field.

TABLE 1. RELATION BETWEEN RELEASES OF *Trichogramma minutum* IN SWEET CORN AND PER CENT OF PARASITIZED *Heliothis obsoleta* EGGS AND AVERAGE NUMBER OF CORN SILKS PER 100 STALKS, SUGARLAND, TEXAS, 1932

Date	Fresh silks Number	Dried silks Number	H. obsoleta eggs Number	Parasitized eggs Per cent
		Average for five acres		
*May 23..	16.4	——	15.8	——
*May 27..	72.6	——	44.0	4.5
May 29..	128.2	——	95.8	15.9
*June 3...	227.0	——	60.6	25.4
June 8...	246.6	136.4	1.2	25.0
		Check		
		Average for three acres		
May 23..	10.6	——	10.6	——
May 27..	81.0	——	30.6	——
May 29..	164.6	——	87.3	1.1
June 3...	264.6	——	58.6	26.1
June 8...	260.6	135.3	9.3	7.1

*Trichogramma released on these dates.

On June 10, two hundred ears were pulled from each of the acres in which Trichogramma were released and from each acre of the checks. These were examined for injured ears by stripping back the shucks. The per cent of injured ears on the acres where Trichogramma had been released was found to be 86.2; on the checks the per cent of injured ears was 81.5. No control by Trichogramma was shown. These data are summarized in Table 2.

TABLE 2. *PER CENT OF INJURY, NUMBER OF EARS WITH ONE, TWO, THREE, OR FOUR WORMS PRESENT, AND NUMBER OF EARS WITH DEAD WORMS PRESENT. EXPERIMENT IN CONTROL OF THE CORN EARWORM AT SUGARLAND, TEXAS, 1932

Injured ears	Ears with worms present				
	1 worm	2 worms	3 worms	4 worms	Dead worms
Per cent	Number	Number	Number	Number	Number
	Trichogramma release, average for five acres				
86.2	445	149	25	5	—
	Check, average for three acres				
81.5	224	59	11	1	17

*Data based on examination of 200 ears per acre.

The second experiment was carried out in field corn in the Brazos River Bottoms near College Station, Texas. Here three plots of one acre each were selected at the south end of a 20-acre field in which to release Trichogramma. Adjoining these on the north three acres were selected as check plots. Trichogramma were released in the first three plots on June 27, June 30, and July 8. The first two releases were at the

rate of 4,000 parasites per acre and the last release was at the rate of 2,000 per acre, making a total of 10,000 parasites per acre. These Trichogramma were also secured from Dr. A. W. Morrill and were of the Louisiana strain.

The same records were taken as in the first experiment. These are summarized in Table 3.

TABLE 3. RELATION BETWEEN RELEASES OF *Trichogramma minutum* IN SWEET CORN AND PER CENT OF PARASITIZED *Heliothis obsoleta* EGGS AND AVERAGE NUMBER OF CORN SILKS PER 100 STALKS. COLLEGE STATION, TEXAS, 1932

Date	Fresh silks Number	Dried silks Number	H. obsoleta eggs Number	Parasitized eggs Per cent
		Average for three acres		
June 27...	4	0	7.3	—
June 30...	33.6	0	34.6	10.5
July 5....	73.6	0	47.6	—
July 8....	80.3	16	18.0	—
July 12...	69.6	42	9.6	—
		Check		
		Average for three acres		
June 27...	4.6	—	6.6	—
June 30...	23.3	—	25.3	—
July 5....	69.3	—	23.3	7.1
July 8....	74.6	—	33.3	—
July 12...	72.6	27.6	34.0	2.9

It will be seen that the amount of egg parasitism in either the experimental plots or the check plots was very low and did not increase as at Sugarland.

On July 12, two hundred ears were pulled from each plot and examined for injury and ears with worms present. It was found, as shown in Table 4, that 69 per cent of the ears on the plots where Trichogramma had been released were injured, while on the check plots 75 per cent were injured. In connection with the per cent of injured ears on the check, one of these plots showed only 62 per cent of the ears injured. The other two plots of the check had 81 per cent and 82 per cent injured ears, respectively. It is possible that there was some spread of Trichogramma with the prevailing wind into plot 1 of the check.

TABLE 4. PER CENT OF INJURY, NUMBER OF EARS WITH ONE, TWO, THREE, OR FOUR WORMS PRESENT, AND NUMBER OF EARS WITH DEAD WORMS PRESENT. EXPERIMENT IN CONTROL OF THE CORN EARWORM AT COLLEGE STATION, TEXAS, 1932

Injured ears Per cent	Ears with worms present: 1 worm Number	2 worms Number	3 worms Number	4 worms Number	Dead worms Number
		Trichogramma release, average for five acres			
69.0	138	24	3	3	34
		Check, average for five acres			
75.0	156	26	6	0	52

The only conclusion which can be drawn from these two experiments is that in neither case was the number of Trichogramma released per acre sufficient to give control of the corn earworm. In the first experiment the check plots showed more uninjured ears than the plots in which the parasites were released. In the second experiment, while there was a gain in uninjured ears in the plots where parasites were released, this was not greater than the variation in number of uninjured ears in the check plots.

LARVAL PARASITES OF THE ORIENTAL FRUIT MOTH IN ROANE COUNTY, TENNESSEE

By H. G. BUTLER, *U. S. Bureau of Entomology*[1]

ABSTRACT

Seventeen species of larval parasites of the oriental fruit moth have been reared from twig-infesting larvae in Roane County, Tennessee. Only one of these, *Macrocentrus delicatus* Cress., is, however, sufficiently abundant to be of importance as a control factor. Over 95 per cent of the parasites reared in this investigation have been of this species.

While 27 colonies, including 6 species, of oriental fruit moth parasites have been liberated in the past three years, none of these species have been recovered in sufficient numbers to indicate that they are effective in this district.

The development of the earlier broods of the oriental fruit moth (*Grapholitha molesta* Busck) in peach twigs, together with the feeding habits of the newly hatched larvae, have made the sprays and dusts commonly used in peach orchards of little value. The practical impossibility of maintaining an effective poison coat over rapidly growing twig terminals during the spring and early summer permits the propagation of two full broods of this pest before the twigs harden and a general attack on the ripening fruit occurs. During this long period the only restrictive forces now known to be effectively operating are those exerted by weather conditions and natural enemies.

The most important of the natural enemies of the oriental fruit moth, during the spring and early summer, are the insect parasites, a large number of which have been found to attack this species in the United States. The degree of control effected by these parasites varies greatly. Some of the species concerned are of negligible importance and others are quite valuable. On the other hand, a particular species may be quite

[1]Mr. Junius C. Clark, Temporary Field Assistant, helped with the work reported in this paper during the spring and summer of 1931.

effective in one district and of minor value elsewhere. Such a condition has been found to exist in Roane County, Tennessee. The investigation of the different species of larval parasites of the oriental fruit moth present in this area and of the importance of each as a control factor was started in 1930 and continued throughout 1931 and 1932.

RECORDS OF 1930 AND 1931.—The larvae used in this investigation were obtained from infested peach twigs gathered in various orchards. These twigs, stripped of their leaves, were confined in battery jars with an apple to supply additional larval food if needed. In 1930 and 1931 the larvae, as they matured, were placed in pupation racks for subsequent observation. In these two years parasitization was determined by the emergence of the parasite larva from the host larva, and not by the emergence of the adult parasite. All oriental fruit moth larvae that entered the pupal stage were counted as normal. The adult parasites that emerged were preserved for later identification. The species determinations herein reported were made by J. M. Aldrich, R. A. Cushman, and C. F. W. Muesebeck, all of the Taxonomic Unit of the Bureau of Entomology, at Washington, D. C. A summary of the records of 1930 and 1931 showing the degree of parasitization found in larvae maturing in each of the spring and summer months is given in Table 1.

TABLE 1. THE DEGREE OF PARASITIZATION FOUND IN LARVAE OF THE ORIENTAL FRUIT MOTH MATURING IN THE SPRING AND SUMMER MONTHS OF 1930 AND 1931

	1930				1931			
	Number of larvae		Per cent		Number of larvae		Per cent	
Month	Normal	Parasitized	Normal	Parasitized	Normal	Parasitized	Normal	Parasitized
May.....	—	—	—	—	13	0	100.0	0.0
June.....	—	—	—	—	604	255	70.3	29.7
July.....	46	48	48.9	51.1	1,075	1,317	44.9	55.1
August...	97	444	17.9	82.1	68	249	21.5	78.5
September	5	56	8.2	91.8	—	—	—	—
Total...	148	548	21.3	78.7	1,760	1,821	49.1	50.9

The total percentage of parasitization, as determined from the records of July, August, and September of 1930, is 78.7, and that for 1931 is 50.9. The omission of records for the months of May and June in 1930 results in a distorted rate of parasitization for that year. The degrees of parasitization in July and August do not vary greatly in the two years. The difference in total percentage of parasitization for the two years is due to the inclusion of data for September in 1930 and for May and June in 1931. An expression of the rate of parasitization found during the year, based on the records of all larvae under observation during the season, is greatly influenced by the variation in the numbers of larvae in each of the several periods. A more accurate interpretation of the con-

ditions is obtained from the rate of parasitization found in the same month for the seasons compared.

RECORDS OF 1932.—A few infested twigs, noted prior to May 7, were collected and placed together as a miscellaneous lot. The first parasite to emerge during the season, *Lixophaga mediocris* Ald., of the dipterous family Tachinidae, came from these twigs.

By May 10 infested twigs were sufficiently abundant to permit their collection for insectary use. The first moth emergence from these twigs occurred May 27, and the first hymenopterous parasites, *Macrocentrus delicatus* Cress., emerged June 13, from twigs collected May 18 and 19. Several days later parasites emerged from twigs collected May 17. No hymenopterous species were reared from twigs collected before this date. It is thus shown that these parasites were ovipositing in the orchard by May 17.

In 1932 infested twigs were confined in battery jars with narrow strips of corrugated paper, and as the strips became partially filled by fruit moth larvae they were removed to a second jar to be held until moths and parasites emerged. However, some emergence occurred in the twig jars, as part of the larvae constructed cocoons in the twig bundles. Parasitization was determined by the emergence of the adult parasites. A summary of the emergence of moths and parasites reared from twig-infesting oriental fruit moth larvae collected each month during the spring and summer of 1932 is given in Table 2.

TABLE 2. THE EMERGENCE OF MOTHS AND PARASITES REARED FROM TWIG-INFESTING ORIENTAL FRUIT MOTH LARVAE COLLECTED IN ROANE COUNTY, TENN.

Month collected	Number of samples	Number of moths	Number of parasites	Total emergence	Per cent parasitization
May	15	1,279	536	1,815	29.5
June	31	3,380	2,937	6,317	46.5
July	37	599	2,399	2,998	80.0
August	18	81	202	283	71.4
Total	101	5,339	6,074	11,413	53.2

The rearing records of 11,413 larvae under observation show that the total parasitization for the season was 53.2 per cent. No parasites were reared from twigs collected between May 10 and 16, but following this period the degree of parasitization rapidly increased until the latter part of July. The maximum degree of parasitization occurred in the interim between July 19 and 25. Rearing records obtained from 17 twig samples collected in this period show that 84.4 per cent of the larvae were parasitized.

PARASITIZATION IN THE FRUIT-RIPENING PERIOD.—A relatively small number of oriental fruit moth larvae attack immature peaches prior to the ripening period. It is not until late in the season that a general infestation of peaches by these larvae occurs. This period normally extends from mid-July until all fruit is removed from the orchards, which may be, in this area, late in August.

The moths emerging from July 8 to August 4 are the immediate progenitors of the fruit-infesting larvae. Records of 1932 show that of the 1,942 larvae from which either moths or parasites emerged during this time 1,346, or 69 per cent, were parasitized. This high rate of parasitization, affecting the most critical part of peach development, the ripening period, affords a more accurate measure of the practical results of oriental fruit moth control by parasites than is given by records for the complete season.

TABLE 3. SPECIES AND NUMBER OF PARASITES OF THE ORIENTAL FRUIT MOTH REARED EACH YEAR IN ROANE COUNTY, TENN.

Species reared	Order	Family	Number of specimens reared 1930	1931	1932	Total
Campoplex sp.	Hymenoptera	Ichneumonidae	–	–	2	2
Cremastus n. sp.[1]	Hymenoptera	Ichneumonidae	–	–	1	1
Cremastus minor Cush.	Hymenoptera	Ichneumonidae	–	1	4	5
Cremastus n. sp.[2]	Hymenoptera	Ichneumonidae	–	10	47	57
Cremastus tortricidis Cush.	Hymenoptera	Ichneumonidae	–	–	5	5
Dioctes obliteratus Cress.	Hymenoptera	Ichneumonidae	–	–	2	2
Eubadizon pleurale Cress.	Hymenoptera	Braconidae	–	–	10	10
Eubadizon sp.[3]	Hymenoptera	Braconidae	–	2	–	2
Eurytoma sp.	Hymenoptera	Eurytomidae	–	–	3	3
Glypta rufiscutellaris Cress.	Hymenoptera	Ichneumonidae	–	2	26	28
Lixophaga mediocris Ald.	Diptera	Tachinidae	–	3	10	13
Macrocentrus ancylivorus Roh[4]	Hymenoptera	Braconidae	26	18	1	45
Macrocentrus delicatus Cress.	Hymenoptera	Braconidae	441	1,550	5,820	7,811
Macrocentrus instabilis Mues.	Hymenoptera	Braconidae	26	–	22	48
Microbracon mellitor Say	Hymenoptera	Braconidae	–	2	–	2
Pristomerus agilis Cress.	Hymenoptera	Ichneumonidae	–	–	70	70
Pristomerus ocellatus Cush[4]	Hymenoptera	Ichneumonidae	1	8	49	58
Secodella n. sp.	Hymenoptera	Eulophidae	–	–	7	7
Undetermined[5]	Diptera	———	–	9	–	9
Total			494	1,605	[6]6,079	8,178

[1]Reared by H. W. Allen from twigs collected in Roane County, Tenn.
[2]At least two unnamed species are present.
[3]Probably E. pleurale Cress.
[4]Introduced species.
[5]Probably L. mediocris Ald.
[6]Includes 5 specimens not listed in Table 2.

SPECIES OF PARASITES REARED.—During the past three years 17 parasitic species, naturally present in this district, have been reared from oriental fruit moth larvae obtained from infested peach twigs collected in the various orchards. With one exception, these parasitic species are of minor importance as a control factor. A tabulation of the number and species of parasites reared each year is given in Table 3.

Macrocentrus delicatus is the most important of the larval parasites of the oriental fruit moth in Roane County, Tenn. Over 95 per cent of the 8,000 parasites reared in this investigation have been of this species.

INTRODUCTION OF PARASITES.—In cooperation with H. W. Allen, of the Moorestown, N. J., laboratory of the Bureau of Entomology, several parasitic species under investigation at that station have been liberated in Tennessee orchards. Recoveries have been made from 6 of the 27 colonies of oriental fruit moth parasites liberated in the past three years. The results from 17 of these colonies, liberated in 1932, will not be available until 1933.

Two colonies of *Macrocentrus ancylivorus* Roh. were introduced in 1930 and 26 specimens were recovered in the same season. In 1931 four more colonies were liberated and 18 specimens were reared from field-collected larvae. Six additional colonies were liberated in 1932 and a single recovery was made. The specimen taken in 1932 came from an orchard in which a colony was liberated in 1930.

Three colonies of *Pristomerus ocellatus* Cush. were liberated in 1931. This species is naturally present, in small numbers, in Tennessee, and, in 1932, 49 specimens were taken in 8 widely separated orchards, including two of those in which colonies were released.

A single colony of *Pristomerus vulnerator* Panz., a European species, was available late in the season of 1931. It was liberated under unfavorable conditions. No specimens have been recovered.

Seven colonies of *Ascogaster quadridentatus* Wesm., a European species which oviposits in the egg of its host, were introduced in 1932. No specimens have been recovered.

Two colonies of *Trichogramma euproctidis* Gir., a European egg parasite, were introduced in 1932. No recoveries have been made.

Two colonies of *Perisierola* sp., an Australian parasite of the oriental fruit moth, were released late in the season of 1932. No specimens have been recovered.

Indifferent success has attended the introduction of parasitic species in this area. *Macrocentrus ancylivorus* Roh., quite valuable in New Jersey, has been unable to increase in numbers in eastern Tennessee.

The single specimen taken in 1932 shows that, while the species has successfully lived over two winters, the population is declining.

The habits of the oriental fruit moth in this district are such that an alternate host seems to be necessary for the success of larval parasites. The abundance of *Macrocentrus delicatus* may indicate the presence of a host suitable for that species but not for *M. ancylivorus*.

A METHOD FOR TIMING SPRAYS FOR THE CONTROL OF SCALE INSECTS ON CITRUS[1]

By L. L. ENGLISH and G. F. TURNIPSEED,[2] *Alabama Agricultural Experiment Station, Field Laboratory, Spring Hill, Alabama*

ABSTRACT

Sprays for the control of scale insects were effectively timed from weekly records of the abundance of crawlers. Such records were made by counting the number of crawlers caught in removable tanglefoot bands placed on infested branches of satsuma orange trees.

Considerable importance has been attached to the timing of sprays for the control of the Codling Moth (*Carpocapsa pomonella* L.) and perhaps a few other insects, but proper attention has not been given to the timing of oil sprays for the control of scale insects. For maximum control with a minimum amount of oil, it is essential that the spray be timed to kill the greatest number of crawlers. In the case of an insect having only one or two generations a year, the problem is relatively simple, but when there are several generations each season, with much overlapping, there is need for quantitative data. The procedure herein reported has been used successfully for two years for timing sprays for the control of scale insects on citrus.

PROCEDURE.—Records are obtained by making weekly counts of the number of scale crawlers caught in removable tanglefoot bands. Three bands are used on each record tree, each band being placed on wood of a different age. Care should be exercised in selecting branches which have an adequate infestation of disease-free scales. The location for the band is scraped free of scales. A strip of transparent mending tape one-fourth inch wide is placed smoothly and tightly around the limb. This is brushed over with a coating of collodion. After the collodion dries a narrow thread of tree tanglefoot is placed around the middle of the band with a hard rubber syringe (Plate 46).

[1]Journal paper from Department of Zoology-Entomology, Auburn, Alabama.
[2]Assigned by Alabama State Department of Agriculture.

On the same day of each week the bands are carefully removed with a spearheaded needle and forceps, pinned in a Schmitt box, and carried to the laboratory for examination. New bands are put on in the same place each week. When one is working with purple scale (*Lepidosaphes beckii* Newm.), long scale (*L. gloverii* Pack.), or chaff scale (*Parlatoria pergandii* Comst.), the bands may be located on the same branches for an entire season. With camphor scale (*Pseudaonidia duplex* Cockll.), however, the bands should be re-located when the number of crawlers is at a minimum, due to the migration of the scale population.

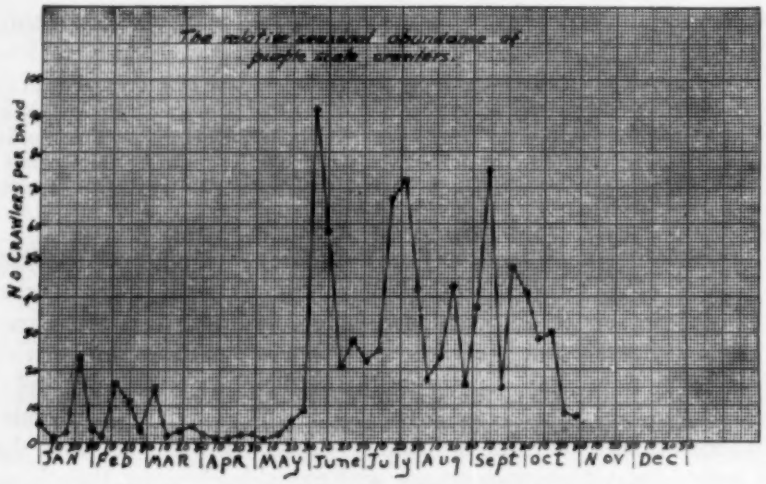

Fig. 83.—Seasonal abundance of purple scale crawlers.

The prediction of a peak hatch becomes easier with experience and increased data. It has been our practice to wait until the week following each peak before advising growers to spray. At that time a high percentage of the scale population is in a susceptible stage. After the first peak of the season has been obtained, the succeeding peaks can be predicted rather accurately from a knowledge of the length of the life cycle or by rearing adults in the insectary from crawlers secured at the peak of hatching.

Results.—Eggs of the purple scale continue to hatch throughout the mild winters of South Alabama, and although there is considerable overlapping of generations, there are three peak hatches during the summer season (Fig. 83). Since at the time of the first peak the satsuma oranges are too small for oil, lime sulphur is applied; at the other two peaks oil is

Removable tanglefoot band on satsuma branch.

used. By following this procedure a high percentage of clean fruit has been obtained even in heavily infested orchards.

It was found that camphor scale could also be controlled quite readily with the aid of this method. Unlike purple scale, this insect does not hatch throughout the winter; moreover, the three summer broods are more distinct and without the overlapping found in purple scale. In the first year's work with this pest the spray was applied without attention to timing. An almost complete failure resulted as the adult females are difficult to kill. During the following two years, sprays were properly timed and a high infestation was brought under satisfactory control.

The procedure described for determination of abundance of crawlers also offers a means of studying the seasonal history of scale insects. It may also be used for the determination of the degree of infestation or for the measurement of the relative effectiveness of sprays which have been applied to large blocks of trees.

A STUDY OF THE EFFECT OF ACCESSORY SUBSTANCES ON THE ADHERENCE OF LIME SULFUR SPRAY TO THE INTEGUMENTS OF PINE LEAF SCALE, *CHIONASPIS PINIFOLIAE* (FITCH)[1]

By WILLARD W. YATES, *Portland, Ore.*

ABSTRACT

A number of common spreaders and adherents are here tested out in lime sulfur spray for their effect in increasing or decreasing the amount of adhering spray solution on the integuments of pine leaf scale. The method used in estimating the relative value of the various combinations was to determine quantitatively, by an adapted colorimetric method, the residual sulfur left deposited on fifty scales. It is apparent from the experimental results that the correct amount of accessory material to use is important, and will depend upon the nature of the surface to be covered. The integument of the pine leaf scale is not difficult to wet. The use of an excessive amount of certain materials with lime sulfur resulted in a reduction in the amount of adhering sulfur. From an economic standpoint, it is evident that the use of an excessive amount of accessory material in a spray is a more serious error than the use of too little material.

The adherence and spread of contact sprays and the physical and chemical forces involved in the process has received considerable atten-

[1]Submitted to the Oregon State Agricultural College in partial fulfillment for the Degree of Master of Science, June 1932.

Credit is due Prof. D. C. Mote and Prof. R. H. Robinson of the Oregon State College for their helpful suggestions and criticisms.

tion. However but little work has been undertaken as to the actual amount of spray solution that adheres to treated surfaces, especially the integuments of insects. In this study lime sulfur spray with and without accessory substances added to it was applied to scale insects, and the residual amount of adhering sulfur quantitatively determined. Sprays when applied to insects leave residual amounts both as external deposits and often as internal penetrants. Present laboratory technique does not permit the determination of the one and not include the other. The data here submitted is a measure of the total spray residue left either on or in the insects treated. Conclusions arrived at are based on the experimental data secured; but in a final evaluation of a spray solution, the other physical and chemical factors involved must all be taken into consideration. The quantity of spray left adhering to the integument of insects is considered to be important, and the magnitude of this deposit should be of aid in determining the relative value of the several spray combinations.

The terms, spreaders, adherents, wetters etc., have been employed to convey slightly different relationships between the spray and the surface it is applied to. The terms, spreaders and adherents, are here used to indicate groups of substances that are usually used either to give improved coverage and film or to cause the spray to adhere better to the sprayed surface. No attempt is made to classify the materials either before they are used or on the basis of the data secured.

EXPERIMENTAL DATA.—A high grade commercial brand of lime sulfur with an adjusted Baume of 31.5 degrees was used in all the tests. This concentrated solution was diluted to give a one to ten solution. This final solution was prepared fresh for each spray combination, and was used as soon as possible after being made. Most of the spreaders and adherents selected for trial are commonly used ones, and have specific recognized values. Selection was made to include materials with widely differing physical and chemical properties. Certain materials were tested because of specific requests from other workers. The amount of the various substances to use is important, and this point was very forcibly brought out during the progress of this work. The non-homogeneous mixtures obtained with the oils and lime sulfur were decidedly against their use. In a large spray tank with higher agitation better mixtures would be obtained than in the laboratory. In order to satisfactorily use the oils, they were first emulsified with .05% of Kayso Spreader. The resulting emulsions were not very permanent, but allowed the oil-lime sulfur combinations to be applied to the insects.

The pine leaf scale, *Chionaspis pinifoliae* (Fitch), was selected for the

first study. This scale is larger than either the San Jose or oyster shell scales, and is also more easily removed from the leaves without adhering tissue. A fresh supply was available during the season of the year this work was being done. According to Metcalf (2), these scales and the oyster shell scales are very similar in composition in as far as wax composition is concerned. These scales are reported to contain 40% of wax and the oyster shell scales 35%. Mature live scales were used in these tests. The spray solutions were prepared in 100 cc lots and a medium size test tube was filled with the solution. Pine needles carrying an excess of scales were tied into loose bundles, and these were immersed in the liquid, immediately removed, and hung on a rack to drain and dry. Fifty scales were then singly and cleanly removed for each test and brushed into the container used for the determinations.

Owing to the small amount of sulfur adhering to the scales, a colorimetric method of determining this sulfur was employed. This method was one modified and adopted by the Agricultural Chemistry Department of Oregon State College for use in determining the sulfur residue left on fruits. (1) This method was slightly modified to adapt it to this work. The fifty scales were placed in 100 cc test tubes and 10 cc of 2% caustic soda solution added. They were kept near boiling point for a half hour or longer to bring the sulfur into solution. After cooling 40 cc of hydrochloric acid (1 part conc. acid to 4 of water) was added together with 2 grs. of sulfur free zinc. The tubes were connected up by means of stoppers with modified Gutzeit tubes and acid catch tubes. The upper tube was 1/8 inch bore and in it was placed a hardened strip of filter paper that had been treated with a 5% lead acetate solution. The reduced sulphide released as hydrogen sulfide reacted with the acetate to give a characteristic black stain of lead sulfide on the paper. These stains were compared with standard stains made using known amounts of sodium thiosulfate. Blanks were run on the untreated insects and the reagents.

The results of these tests made on scale insects are reported in Table 1. The average results of the several analyses are given in the fifth column as milligrams of sulfur and then these figures, after correcting for the blank, are used in graphically showing the relationship between the various combinations by the solid horizontal lines drawn to scale.

All tests were made in an upstairs laboratory and temperature and humidity varied within a narrow range. Records of these were kept, but as no correlation seemed to exist between them and the results secured, they are not included here.

TABLE 1. RESULTS OF SULFUR DETERMINATIONS WITH FIFTY SCALE INSECTS USING VARIOUS SPRAY SOLUTIONS

Spreaders and adherents used with 1 to 10 lime sulfur solution	Am't used %	Duplicate determinations (Length stain in mm.)		Ave. stain	Mgs of sulfur	Results graphically presented 0.1 mg. of S. = 5 cm. (Corrections for blank deducted)
Lime sulfur only	—	38.5	45.0			
		38.5	48.0			
		37.0		41.4	.082	
Blank on reagents plus scales	—	2.0	1.4			
		1.1	1.6	1.3	.0266	–
Prepared Calcium caseinate (4 pts. casein to 1 lime)	0.5	41.0	38.0			
		33.0		37.3	.0739	
same	0.1	52.0	51.5	51.7	.1035	
same	0.05	48.0	70.0			
		56.0		58.0	.1164	
Dried skim milk	0.1	45.0	50.0			
		52.0		49.0	.0979	
Fresh liquid skim milk	1.0	42.5	40.0			
		57.0		46.5	.0926	
Blood albumin (tech.)	0.5	38.5	27.5			
		33.0		33.0	.065	
same	0.1	43.0	55.0			
		44.0		47.3	.0945	
same	0.05	38.0	44.5	41.3	.082	
White Dextrin (tech.)	1.0	39.0	36.5	38.7	.0768	
same	0.5	57.0	55.0	56.0	.1122	
Soluble Starch (tech.)	1.0	36.0	37.5			
		26.5		33.3	.0656	
same	0.5	53.5	59.5			
		35.8		49.6	.099	
Gelatine (tech.)	0.5	43.0	37.0			
		39.5		39.5	.079	
Saponin (C.P.)	0.5	34.0	28.0			
		35.0		32.3	.0636	
same	0.05	38.7	51.5			
		68.5		52.9	.1058	
Hard Wheat Flour	1.0	48.0	50.0			
		40.5		49.5	.099	
same	0.5	41.0	41.5	41.3	.082	
Kaolin (acid washed)	1.0	55.0	51.0			
		40.0		48.7	.0972	
Pipe Clay (potters)	1.0	53.0	52.0			
		40.5		48.5	.0969	
Sodium Silicate (tech.)	1.0	78.5	79.5			
		59.0		72.3	.1455	
*Waste sulfite liquor residue	1.0	26.0	25.8			
		41.5		31.1	.0555	
Cottonseed Oil + .05% Kayso	1.0	53.5	57.0	55.3	.1108	
Linseed Oil + .05% Kayso	1.0	61.5	82.0			
		74.0	44.0	65.4	.1315	
Fish Oil + .05% Kayso	1.0	42.0	39.5			
		75.5	75.0	58.0	.1162	
Fish oil resin spreader	0.5	24.4	32.0	28.2	.0552	
Kayso Commercial spreader	0.5	31.5	30.5	31.0	.0609	
	0.05	61.0	70.5			
		59.3		63.6	.1277	

*Blank for this was 4. Omm, a product prepared from waste sulfide liquor from paper mill.

DISCUSSION AND CONCLUSIONS.—A study of the table shows that of the 28 combinations used on the insects, 16 gave an increase in residual sulfur over that given by lime sulfur alone, 4 gave approximately the same, and 7 gave less. The oils and the sodium silicate combinations proved to be the best in so far as total sulfur is concerned. The drying linseed oil gave a higher deposit than either the semi-drying fish oil or the cottonseed oil. Dried skim milk at 0.1% gave nearly the same results as liquid skim milk at 1.0% concentration. It required more blood albumin than calcium caseinate to get as good a coverage. Some of the materials that were experimented with and gave poor or indifferent results at the concentrations used would probably at a higher or lower level make a better showing. It was not possible because of the time limit to test a wide enough range of concentrations, nor use the substances with any other spray solution besides lime sulfur, and therefore the actual evaluation of the various substances for competitive value cannot be made.

Marked differences occurred where the amount of certain accessory materials was varied. Calcium caseinate at 0.5% gave less adhering sulfur than the lime sulfur alone, 0.1% improved the coverage, while the 0.05% concentration gave the greatest amount of residual sulfur. Blood albumin used in the varying amounts did not show such extreme values, but the intermediate concentration of 0.1% gave better coverage than either the stronger or weaker mixtures. Combinations of several of the accessory materials where more than one concentration was tested also bring out the importance of using the proper amount of a spreader or adherent.

These tests with the various spray combinations have shown that the amount of accessory substance that is added to a given spray solution is very important. Materials chiefly valuable for their spreading properties will undoubtedly have more effect on a spray solution, when the amount used is varied, than those substances that are primarily adhesives. Woodman (4) has gone into this question of influence of accessory substances in spray combinations rather extensively. He defines as the "critical surface tension," the point where the surface tension of the liquid has been reduced, and the maximum amount of a spray fluid is retained. Failure to reach this point results in imperfect wetting and after it is reached, surface tension ceases to be a dominating factor influencing the volume of liquid retained by a surface. The results reported here show that there is a point, corresponding to the critical surface tension point of Woodman's, where the amount of material used results in a maximum deposit of spray and if more material is

used not only is no additional deposit secured, but the amount of deposited spray will actually be decreased to less than if no spreader had been used. It would appear from these findings that in actual field spraying operations the use of too little spreader from the standpoint of maximum spray deposited would not be as serious a mistake as the addition of an excessive amount.

The integument of a scale insect represents a certain peculiar surface, but one that is not particularly hard to wet with lime sulfur as it has a certain undetermined absorptive and adsorptive power. The physical forces were not measured, but lime sulfur gave a rather even uniform coverage to the scales. Observations indicated that with the method used where the leaves were immersed and the scales drenched with solutions, there was no creeping of the spray away from the insect covering as reported by O'Kane and Conklin (3).

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3. O'Kane, W. C., Westgate, Glover, and Loury. 1930. Surface tension, surface activity, and wetting ability as factors in the performance of contact insecticides. N. H. Agr. Exp. Sta., Tech. Bull. 39.
4. Woodman, R. M. 1924. Physics of spray liquids. 1—Properties of wetting and spreading. J. of Pomology and Hort. Sci. 4: 38–58.

Scientific Notes

Chinch bug (*Blissus leucopterus* **Say**). There has been serious injury the past season to lawns by this insect in southwestern New England, western Long Island, southern New York, northern New Jersey and sections in the vicinity of New York City. Lawns previously in good condition became badly spotted with brown areas. The affected grass, if nothing was done, soon died. It is possible to kill many of the insects by repeated applications of a contact insecticide, such as tobacco dust, a nicotine sulfate-lime dust or a potassium oleate and Black Leaf 40 combination. These do not kill the eggs and afford but temporary relief. There is a possibility that fumigating with a carbon disulfide emulsion under canvas will give more efficient control.

E. P. Felt

The pine tip beetle (*Pityophthorus pulicarius* **Zimm.**) has been unusually abundant and injurious to Austrian pine in particular at Greenwich, Conn., Bedford Hills, N. Y., Southampton, L. I., and in the Philadelphia area. An infestation is indicated in midsummer by some three or four inches of dead tips with brown needles. The numerous burrows made by this insect are less than a sixteenth of an inch in diameter, and not infrequently the insects may be found in the affected tips. A severe infestation appears to result in the gradual killing back from the affected tip and may

ultimately involve most of a good sized branch. A general infestation may result in most of the tips and a large proportion of the tree becoming badly browned in midsummer. This condition appears to result from an infestation of several years standing, which permits a gradual increase in the numbers of the insects and corresponding damage.

E. P. FELT

Reappearance of the Colorado Potato Beetle in Utah. The Colorado potato beetle has been reported several times from Utah (Jour. Econ. Ent. 25: 134). Small outbreaks occurring in Morgan and in Utah Counties, apparently were exterminated. This year Colorado potato beetles were found injuring potato vines in a number of fields south of Ogden, over an area of a few square miles. Only part of the potato fields were infested, but some farmers reported that this insect had been found on their potato plants during the past two to three seasons. The small area in which Colorado potato beetles were found extends to about one and one-half miles north of Riverdale, south through Roy to Sunset and Clinton, extending a short distance into both Weber and Davis Counties. The infested area is traversed by two railroad lines. It is possible that the infestations came in on railroad cars.

GEORGE F. KNOWLTON, *Utah Agricultural Experiment Station*

Preparation of Derris Extract Sprays. In preparing sprays with commercial concentrated acetone extracts of derris (containing from 2.3 to 5 grams of rotenone per 100 cc. with a total of 16 to 18 per cent derris extractives) large quantities of precipitates were formed when 1 part of the extract was added to 250 to 500 or more parts of water, soap solutions, or solutions of various other wetting agents. Not only are such precipitates apt to clog spray nozzles but it is also likely that they contain active constituents which might be less effective in such a poorly dispersed state. It was found that coagulation could be overcome and a milky dispersion of the extractives obtained by diluting the extract with acetone (1:1) before adding it to water or to aqueous solutions of various wetting agents. Residues from sprays so prepared retained their toxicity to thrips much longer when sulfonated castor oil (1:400) was used as the wetting agent instead of potassium coconut oil soap (1:300). Sulfonated castor oil (turkey red oil) at 1:400 wet effectively the foliage of various plants, including gladiolus, rose, and onion.

HENRY H. RICHARDSON, *Assistant Entomologist,*
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Specific Defoliation Data on Apple. The need for an accurate method of evaluating leaf drop on apple has never been more apparent than at present. Due to the spray residue situation, new sprays and combinations are being tried, and resultant injury is being experienced in varying degrees. Leaf drop is the most common, most definite, and most serious form of foliage injury. For several years entomologists at the Ohio Agricultural Experiment Station have experimented with different methods of securing accurate data on defoliation. This season a method has been used in which the leaves on wood of the current season's growth are considered. Defoliation almost always starts with the leaves at the base of such growth and then proceeds toward the tip. As each leaf drops it leaves a record of its former presence in the shape of a definite leaf scar. By counting such scars and the remaining leaves that

may be present an exact record of the defoliation status may be obtained. The writer has found that a count on 20 terminals per tree is a sample large enough for accuracy.

M. A. Vogel has also successfully used this method in determining relative rates of spray injury on peaches.

C. R. CUTRIGHT, *Associate Entomologist, Wooster, Ohio*

The Past and Present Status of Fluorine Containing Insecticides.[1] During 1915, there appeared two publications, one by Marlatt (U. S. Dept. Agri. Bul. 658), and another by Schafer (Mich. Agr. Exp. Sta. Tech. Bul. 21), recommending the use of sodium fluoride as a control for roaches. These two papers seem to be the first to recommend a fluorine containing salt to be used as an insecticide in the United States.

Very little was done concerning their possible insecticidal use from that date, until 1924. However, from 1924 until 1932 considerable research was carried on at several Agricultural Experimental Stations, as well as the Bureau of Entomology at Washington, D. C. The ravages of several important economic insects throughout that period may also have stimulated the discovery and recommendation of new insecticides, because of the relatively ineffectiveness of the insecticides then in use.

During 1932, there appeared several publications by Smyth and Lantz; Smyth, Lantz & Smyth (Jour. Dental Res. 12: 149–159, Ibid 12:552–556, Jour. Agr. Res. 12:554 and Dental Survey March issue), covering the chronic effects of fluorine. For a short time their data brought about a slight curtailment in the amount of research using the salts of fluorine as insecticides.

The appearance of these adverse data, seem to have brought about a sad misjudgment by some, of the entire insecticide field. The discovery of the perfect or completely satisfactory dual purpose insecticide is still something for the enthusiastic entomologist to look forward to. Results from several investigators show definitely where certain arsenicals are relatively specific for certain purposes. We must then conclude that these salts of arsenic still have, and will have for some time to come, a definite place in our insecticidal category.

As much or more can be said for the fluorine containing insecticides, since the results of Marlatt (U. S. Dept. Agr. Bul. 658:1915) and Schafer (Mich. Agr. Exp. Sta. Tech. Bul. 21:1915) have been confirmed by a goodly number of investigators.

The insecticidal use of fluorine containing compounds has been more strikingly brought forward since that time by the investigations of Roark (U. S. Patent No. 152484; 1925), Herrick (Proc. 71st Ann. meeting N. Y. State Hort. Soc.; 4217; 1926), Gentner (Mich. Agr. Exp. Sta. Bul. 155; 1926), Ripley (Bul. Ent. Res. 15:29–34; 1924), Marcovitch (Tenn. Agr. Exp. Sta. Bul. 131; 1925—Jour. Econ. Ent. 18:122–128; 1925), and numberless others who have found specific uses for several different salts of fluorine. In many instances the results obtained were far superior to other insecticides, when compared under similar circumstances.

The two latest, and possibly the most promising of these fluorine containing compounds are cryolite and barium fluosilicate. Their margin of safety for foliage application, exceedingly high toxicity to insect life, and relatively low toxicity to man, when compared with lead arsenate (Smith & Smith, Jour. Ind. & Eng. Chem. 24:229; 1932), (Sollman, Schettler and Wetzel, Jour. Pharm. and Exp. Ther. 17:197–225; 1921) and Sollman, Jour. Pharmacol. 18:43–50; 1921, have led the writer to believe that under average rainfall conditions, these two compounds definitely have a place

[1]Prepared from a review of literature pertaining to insecticides and their use.

among our insecticides. Cryolite, because of its moderate solubility (Carter, Jour. Ind. and Eng. Chem. 20:1195; 1928, Marcovitch & Stanley, Jour. Econ. Ent. 23: 370–376; 1930), seems to lend itself almost ideally when we consider the above limiting factors. To date the writer has been unable to find complete published information concerning its comparative residual effects and compatibility with other insecticides.

Let us not forget that some of these fluorine containing salts may, under certain conditions, become some of our most welcome and satisfactory insecticides.

C. M. GWIN, *Entomologist, Arwell, Inc., Waukegan, Ill.*

The Use of the Term "Pyrethrin" by Entomologists.[1] An unfortunate confusion in the use of the term *pyrethrin* exists in the literature of plant chemistry. Few entomologists are aware that this term was used first in 1876 by Buchheim[2] to designate the active principle in the roots of *Anacyclus pyrethrum* (Linn.) De C., or pellitory of medicine. Because *Pyrethrum* was for a long time also the generic name of plants which are the source of insect powder, the term *pyrethrin* has been used recently for the active principles of that insecticide. A brief survey of definitions of *pyrethrum* in recent editions of various medical dictionaries shows a real confusion in the use of the term. A few facts concerning the nature and source of pellitory and of insect powder, as well as the history of the term *pyrethrin*, will help in making clear the reason for the existence of such a condition.

Anacyclus pyrethrum (Linn.) De C., belonging to the Compositae, is commonly known as pellitory. It grows principally in northern Africa. The root is used in medicine as a counter-irritant and sialogogue, although it is stated in the Dispensatory of the United States of America[3] that this drug is very rarely employed today. Pellitory was deleted from the present United States Pharmacopoeia X, but it was included under the name *pyrethrum* in many of the earlier editions. In Europe, *radix pyrethri, Bertram root*, and variations of these names are used. *Anacyclus officinarum* Hayne, the root of which is known by substantially the same names, grows in Germany.

Chrysanthemum species that are the source of insecticidal pyrethrum were grown originally in southeastern Europe and southwestern Asia. In this case, it is principally the flower head instead of the root that contains the active compounds. When *pyrethrum flowers* (*flores pyrethri*) are mentioned reference is certainly to the flowers of a *Chrysanthemum* (*Pyrethrum*) species. French usage prevents ambiguity with the expression *pyrèthre insecticide*.

Prior to Buchheim's suggestion of the term *pyrethrin*, Parisel[4] in 1833 gave a similar name, *pyrétrine*, to an active resin he extracted from pellitory. Thompson[5] has been given credit by Czapek[6] (p. 294) for applying the name *pyrethrin* in 1887, although Czapek (p. 252) also refers to Buchheim's previous usage (1876). Dunstan and Garnett[7] proposed the name *pellitorine* in 1895 for the physiologically active,

[1]Published as Paper No. 1180 of the Scientific Journal Series of the Minnesota Agricultural Experiment Station.

[2]R. Buchheim, Archiv. f. Exp. Path. u. Pharm., 5: 455–462. 1876.

[3]The Dispensatory of the United States of America. 21st edition, 1926.

[4]L. V. Parisel, Jour. de Pharm., 19: 251–252. 1833.

[5]C. J. S. Thompson, Pharmaceut. Jour., (3) 17: 567. 1887.

[6]F. Czapek, Biochemie der Pflanzen, Vol. 3. 1921.

[7]W. R. Dunstan and H. Garnett, Jour. Chem. Soc. (Lond.), 67: 100–102. 1895.

crystalline principle of pellitory. They say, "It is very probable that it is the same substance as that isolated, but very imperfectly examined, by Buchheim, in 1876, and named by him *pyrethrine*." In 1896 Schneegans[8] spoke of *pyrethrin* as the active constituent of *Anacyclus pyrethrum*.

Insect powder was investigated in 1909 by Fujitani,[9] who is responsible for the first analytical work of much significance on it. He found a physiologically active ester which he called *pyrethron*. Yamamoto[10] worked with the same substance in 1918 and used Fujitani's name for it. Staudinger and Ruzicka[11] found the principle to consist of two related esters which in 1924 they called *pyrethrins* I and II. They reported that Fujitani's *pyrethron* was the same as their mixture but contained somewhat more than fifty per cent of impurities. Their action in changing an established name is hard to understand. Furthermore, the fact that their name was already in use should have been easily ascertainable from various medical and botanical reference works. In 1927, Ott and Behr[12] pointed out this use of the same name for two widely different chemical products of the respective plants and claimed *pyrethrin* for the principle in Bertram root on the basis of priority. On the other hand, Gulland and Hopton[13] proposed in 1930 to retain Dunstan and Garnett's name *pellitorine* "in preference to the earlier 'pyrethrin' in order to avoid possible confusion with the constituents of *Pyrethri flores*, the dried flowers of pyrethrum species which are used in powdered form as insecticides."

Under the circumstances it might seem obvious that the term *pyrethrin* should be retained for the active principle of pellitory and another name used for that of the insecticide. Fujitani's term *pyrethron* for the latter has priority but it has not been widely accepted and is too similar to be an improvement in nomenclature. On the other hand, pellitory is a drug of minor and waning importance, whereas extracts of pyrethrum flowers are very widely used and are becoming increasingly important as insecticides. The term *pyrethrin* for the active esters in the flowers, though originally incorrectly applied, is so generally used by plant chemists, pharmacologists and entomologists that it is neither feasible nor desirable to attempt its restoration to the original usage. However, ambiguity should be avoided by reference to its plant source.

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The Honey Bees of Africa. Having before me a large collection, from nearly all parts of the Ethiopian region, I have tried to understand the taxonomic problems involved. In a recently (1929) published paper, A. S. Skorikow offers a revisionary treatment of *Apis* on a new basis. His map shows the whole of continental Africa, south of the Sahara, as occupied by *A. adansoni* Latr., while Madagascar is the home of the black *A. unicolor* Latr. Enderlein (1906) recognized from Africa a subspecies *unicolor* of *Apis mellifera* L. (*mellifica* L.), distinguished by its smaller size, the workers about 10–12 mm. long, with anterior wings 8 to 9 mm. This subspecies was divided into two groups, one with the abdomen black, the other having reddish fulvous markings as in *A. mellifera* var. *ligustica* Spinola. The black ones are again

[8]Schneegans, Abstract in Chem. Zentr., 2: 945. 1896.
[9]J. Fujitani, Archiv. f. Exp. Path. u. Pharm., 61: 47–75. 1909.
[10]B. Yamamoto, Abstract in Botanical Abst., 5, No. 840.
[11]H. Staudinger and L. Ruzicka, Helvet. Chim. Act., 7: 177–201. 1924.
[12]E. Ott and A. Behr, Ber. Deutsch. Chem. Ges., 60B: 2284–2287. 1927.
[13]J. M. Gulland and G. U. Hopton, Jour. Chem. Soc. (Lond.) (I): 6–11. 1930.

divided into those without greyish bands of tomentum on the tergites, the Madagascar *unicolor*, and those with such bands, which may have a black scutellum (var. *intermissa* Butt. Reep.), or a fulvous one (var. *friesei* Butt. Reep.). The *ligustica*-like races are *adansoni*, with yellowish hair on thorax and dark hair on vertex, and *lamarckii* Ckll. (*fasciata* Latr., preocc.), with whitish hair on thorax and few dark hairs on vertex. The latter is from Egypt, and is properly a member of the Palaearctic fauna. A careful examination of the material indicates that all the forms may properly be considered races or subspecies of *A. mellifera*, not more distinct than the African races of *Homo sapiens*. Size is variable, but it is now impossible to determine how much this may be due to crossing with European *A. mellifera*, brought over by the settlers. A worker from Aburi, Gold Coast (*L. Armstrong*) could only be referred to true *A. mellifera*, but in general the *adansoni* from all over Africa look much alike, and the climatic regions, warmer or cooler, wetter or drier, do not appreciably affect their appearance. In Rev. Zool. Bot. Afr., XXIII, p. 22, I gave a list of localities for *adansoni*. I can now add that it extends southward into South Rhodesia (*Jesse, J. Ogilvie*; Matopo Hills, *L. Ogilvie*); Orange Free State (Ficksburg, *L. Ogilvie*); Natal Amanzimtoti, *W. P. Cockerell;* National Park, *L. Ogilvie*); Ingogo, *A. Mackie;* Greytown, *L. Ogilvie;* Durban, *J. Ogilvie;* and the Cape Province (Port Elizabeth, *L. Ogilvie;* Camps Bay, *R. E. Turner;* Mossel Bay *R. E. Turner;* Nieuwoudtville, *L. Ogilvie;* Calvinia, *A. Mackie*). There is, however, a black form, parallel with the black honey-bee of Europe. This is what Buttel-Reepen called *intermissa*. The bands of grey tomentum are not always evident, being hidden when the abdomen is contracted. These black *intermissa* bees are common in the south, especially in the Cape Province (near Cango Caves, *J. Ogilvie;* Huguenot, *L. Ogilvie;* Graaf-Reinet, *J. Ogilvie;*Montagu Pass, *L. Ogilvie;* Doorn River, *L. Ogilvie;* Oudtshoorn, *J. Ogilvie;* Nieuwoudtville, *Cockerell;* Naauwpoort, *J. Ogilvie*); but also in Natal (National Park, *J Ogilvie*) and in the Transvaal (Kruger National Park, *J. Ogilvie*). The same insect is known from various places in East Africa, as far north as Nairobi, and it enters the drier part of the Belgian Congo (Lukulu in Katanga, *G. F. de Witte*). In a general way, it may indeed be said that true *adansoni* is characteristic of tropical Africa, and the dark *intermissa* of the drier and in part cooler regions to the south and east. But it may be possible, or probable, that the early Dutch settlers brought the European black bee, and that this has crossed with the native *adansoni*. It would perhaps now be impossible to determine whether there were any black bees in South Africa before the Europeans arrived. The extensive experiments now being carried on at Pretoria, producing crosses between *mellifera* and *adansoni* races, may throw light on this problem. However, black bees from the Kivu highlands (Tshibinda, *J. Ogilvie, L. Ogilvie;* south of Bukavu, *Cockerell*) have the abdomen as in the Madagascar race *unicolor*, and I do not at present see how they are to be separated from that form. The occurrence of *unicolor* in the mountains near the Equator is of much interest.

I tried to find structural characters in the venation, but although they are in some cases striking, they are not constant. Authors have attached great importance to a small character in the hind wings. At the narrowly truncate end of the mediellan cell arise two appendicular veins, one from the upper, one from the lower corner. In the Oriental form *A. indica* Fab. it is said that the vein from the lower corner is always present, whereas in the European and African races it is absent or at best represented by a minute rudiment. I have a specimen of *A. indica* from Manila. P. I. (*McGregor*) in which it is wholly absent, but very likely there has been crossing

with *A. mellifera*. In a male from Kansenia, Katanga, Belgian Congo (*de Witte*) the vein from the lower corner is quite well developed, though I find it in no other African males. I have marked this specimen *A. mellifera*, variety. In a worker of *lamarckii* I find that the vein from the lower corner is absent, but that from the upper corner is a mere rudiment. This insect has a yellow scutellum, and its distinction from the var. *cypria* Pollm., described from Cyprus, seems rather elusive. My impression is that *lamarckii* (of which I have only one specimen, from F. Smith's collection) belongs rather with the European than the Ethiopian races. The anterior wing is 9 mm. long. Taking up a male *A. mellifera ligustica* from Mesilla Park, New Mexico, I found some striking characters in the venation of the anterior wing. The third intercubitus (outer side of third cubital cell) is little flexuous (very strongly flexuous in the Kansenia male). The lower side of the third cubital cell receives the second recurrent nervure far beyond the middle (not greatly beyond middle in Kansenia male), the face of the second cubital cell on first discoidal is very short, not nearly equal to half length of first cubital cell on first discoidal (nearly equal to half in Kansenia male). These characters are so pronounced that one could believe the insects distinct species, notwithstanding their close agreement in other respects. But on examining various specimens from various places, the characters do not hold well, though the general tendency is much more toward the Kansenia than the Mesilla Park characters. Is this perhaps a result of racial crossing, and does the pure *ligustica* actually have good venational characters?

Males referred to the dark *intermissa* form have no yellow bands on the abdomen, and the hair of the scutellum is black or sooty. These come from Kinangop (*Turner*) and Nairobi. Many South African *intermissa* workers have a red band on base of second tergite (Nieuwoudtville, Graaf-Reinet, Huguenot).

T. D. A. COCKERELL, *Boulder, Colorado, July 29*

IMPORTANT NOTICE

The American Association of Economic Entomologists at the Atlantic City meeting adopted the following recommendation of the Membership Committee to: "Study the classes of membership in the Association with the idea of possibly combining the present associate and active membership, or recommending specifications more clearly defining qualifications for the present classes of membership, and submit a report at the next annual meeting."

In addition to the various obvious reasons on which there is no desire to influence anyone as to his opinion, the Membership Committee desires to point out how difficult it is to determine those eligible for transfer from associate to active membership, and that no two membership committees have used the same standards and few members have the same standards in mind in making recommendations for such transfer.

You are urgently requested to send in a discussion of your views on these two questions: (1) Do you prefer two classes of membership as at present or do you prefer one class of membership with all members on equal status; (2) In the event two classes of membership are continued, what definite qualifications do you recommend for the advancement of an associate to active membership.

IMPORTANT.—Those interested should send their remarks promptly to W. H. Larrimer, Chairman of Membership Committee, American Association of Economic Entomologists, Bureau of Entomology, U. S. Dept. of Agriculture, Washington, D. C.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

OCTOBER, 1933

The editors will thankfully receive news matter and other items likely to be of interest to our readers. Papers will be published as far as possible in the order of reception, except that papers of reasonable length may be accepted in the discretion of the editor for early publication at $3.00 per page. There is a charge of $3.00 per page for all matter in excess of six printed pages, a part page counting as a full page, this limit not including acceptable illustrations. Photo-engravings may be obtained by authors at cost.

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A. A. A. S. Winter meetings: 1933-34 Boston; 1934-35 Pittsburgh; Summer meetings: 1933 Chicago. 1934 San Francisco.

The value of an entomological paper depends in large measure upon the authenticity of the identifications. It is true that years of study and experience have made us acquainted with many insects and their variations within specific limits. This has tended to obscure somewhat the fundamental importance of correct names and yet an invesitgator must know what insects he is studying. It is not simply a question of counting hairs, ascertaining the arrangement of scales, or discovering the peculiarities of minute structures. The problem is to learn the combinations of characters which separate groups Nature recognizes as species—those which reproduce themselves and behave in the same manner under varied conditions. This is relatively easy with the larger better known insects. It is an impossible task for one to distinguish accurately between all of the multitudinous forms we know as insects. The accurate identification of most insects is and must of necessity be relegated to specialists or groups of specialists and their work, though usually done in the seclusion of a laboratory is of fundamental importance in all work in economic entomology. There is in this number one paper on parasites. These insects could be named only by specialists and without their aid, the paper would have little value. Another contribution in this issue is limited to an obscure group containing a few economic species. It could be written only by a specialist. These facts are recognized in a general way by all entomologists. It is doubtful

if many economic workers fully realize their dependence upon the tireless, careful studies of the specialists or systematists. It is well known that appropriations are much more easily obtained for investigations or studies of destructive pests in the field than for groups engaged in ascertaining criteria for the identification of the pests and their allies. It is not only essential that specialists recognize all native insects in their respective groups but they are frequently called upon to name specimens from all parts of the world. This latter is due to insects frequently being brought into the country by various commercial agencies in spite of our comprehensive and efficient quarantine service. We must have specialists for the identification of insects. Let us recognize their value more fully, acknowledge our indebtedness to them freely and do all that is possible under present conditions to maintain services of this character unimpaired.

It is a long step from a Kansas farm boy to the Chiefship of the Federal Bureau of Entomology with its millions of appropriations, or the Headship of the quarantine service with approximately equal resources. This was taken, by Dr. C. L. Marlatt, who on the completion of 45 years of governmental service, a notable record of itself, has retired on account of age limitations. There is more than the mere matter of personal achievement in this record. One of the founders of the Kansas State Agricultural College, the Institution which gave Dr. Marlatt his training and presumably initial interest in entomology, was his father, and the college itself was located on a portion of the paternal acres. During this period of 45 years, Dr. Marlatt has seen the appropriations for the entomological work of the Department of Agriculture increase from approximately $50,000 annually to about $6,000,000, if we include, as should be done, the funds devoted to quarantine work as well as those for the research activities of the Bureau. He took a leading part in securing the enactment of a Federal quarantine law and administered that with a high degree of success for about 17 years, turning over this activity in 1929 to Dr. Lee A. Strong, who now succeeds him as Chief of the Bureau of Entomology. It was Dr. Marlatt who was responsible in considerable measure for the expenditure in 1927 of $10,000,000 in a gigantic experiment or demonstration in relation to the value of systematic clean-up measures for the control of the European corn borer. His was the guiding hand in the costly eradication of the Mediterranean fruit fly. The cooperation and team work between the veteran, now retired, Dr. L. O. Howard and his successor, Dr. Marlatt, extending over a period of 40 years, is noteworthy. Their combined efforts did much to build up the Federal Bureau of Entomology from a

comparatively insignificant organization to one providing unparalleled service in this country and with a literally worldwide influence. It is almost impossible to think of one of these men without the other. Dr. Howard's medical training was of great value in his widely known investigations of the relations between insects and certain diseases of man. The record of Dr. Marlatt abundantly justifies the training of earlier years in the Kansas State Agricultural College. It is one of the many admirable records made by graduates throughout the country of the relatively new land grant colleges. It is more than probable that Dr. Marlatt will continue to take an active interest in some phase of entomology. His successor, Dr. Lee A. Strong, is intimately acquainted with affairs through his four years administration of the Bureau of Plant Quarantine. He is most willing to cooperate with entomologists throughout the country and is determined that the prestige of the work shall not suffer. He may be assured that all entomologists gladly endorse such a program and may be counted upon for aid in its accomplishment.

Current Notes

Professor Herbert Osborn of Ohio State University has been made Professor Emeritus in Zoology and Entomology and, in conformity with provisions of the State Teachers Retirement System, retires from active teaching duties. He will continue with his research work especially on Homoptera and as Director of the Ohio Biological Survey.

Mr. A. C. Gould, Apiary Inspector of the New York Department is having markedly good results in cleaning up American foulbrood on the area cleanup plan. The area is under intensive inspection and has shown a marked reduction in disease during the past three years, and it is thought that continuous intensive inspection of these areas will not be necessary in the future.

The Research Laboratory of the Pennsylvania State College located at Arendtsville will be discontinued. This laboratory was established in 1918 for the purpose of studying fruit insect and disease problems. The laboratory will be officially closed on October 1, 1933, and S. W. Frost will be transferred to State College. This move is a result of a desire to centralize the work at The Pennsylvania State College and eliminate field stations.

Frank F. Lindstaedt, who for the past seven years has been Director of Research for the Colloidal Products Co., and Hercules Glue Co., of San Francisco has resigned that position to establish a practice as consulting chemist. He will specialize in insecticidal and colloidal chemistry. Mr. Lindstaedt's researches in the past have resulted in the discovery of several new insecticides, spray compositions and improvements in spreaders. He has opened a well equipped laboratory for conducting his future investigations and researches at 2029 46th Ave., Oakland, California.

Porto Rico, because of its similarity in climate and topography to the Island of Mauritius in the Indian Ocean, has been selected by the Imperial Institute of Ento-

mology for the collection of parasites of white grubs to send to Mauritius. Mr. W. F. Jepson arrived from England early in May, his first collections being of over 2,000 adult "cucubanos," *Pyrophorus luminosus* Illiger, the larva of which is predaceous on white grubs and on soil-inhabiting insects generally. About half of these were sent in cold storage to England, enroute for Mauritius. The others were sent by air-plane express to Barbados, arriving there three days later without a single mortality. (The white grub of Mauritius, *Phytalus smithi* Arrow, originally came from Barbados.

Mr. R. W. E. Tucker of Barbados, spent a month in Porto Rico assisting in the collection of parasites. Mr. Tucker states that a few years before he came to Barbados, as one result of an anti-malaria campaign, all pools in which the giant introduced toad, *Bufo marinus*, might breed, were filled in or drained, and in recent years the cane growers were complaining of much greater injuries in their fields due to white grubs. This is exactly the reverse of what is happening in Porto Rico, where the numbers of this recently introduced toad are becoming so great as to exert an appreciable influence on white grubs, so much so indeed that they are now much less serious pests than previous to the introduction and spread of *Bufo marinus*.

The 29th quarterly meeting of the Entomological Club of Southern California was held on September 8 at the Elks' Club, Alhambra with 76 members in attendance.

Included in the program was a discussion of the Citrus pests of South Africa by C. J. Joubert of Stellenbosch University, who is spending the year in study at the Citrus Experiment Station; the Early History of the Red and Yellow Scales in California by Harold Compere, Citrus Experiment Station; a brief discussion of the status of the Alfalfa Weevil in California by A. E. Michelbacher of the University of California, Berkeley, as an introduction to a talk by S. E. Flanders of the Citrus Experiment Station on Introducing Alfalfa Weevil into California; an elementary course in statistics entitled "What does Plus and Minus Mean?" by Wm. Moore of the American Cyanamid & Chemical Corporation.

C. I. Bliss of the Bureau of Entomology reported on the Salt Lake City Meeting of the Pacific Slope Branch, A. A. E. C., while several members reported entomological items of interest such as the wide spread injury this year to young citrus fruits in Southern California by *Platynota tinctana* Walker (E. A. MacGregor); the abundance of *Pseudococcus citri* (R) on citrus in certain districts, particularly following an oil spray program for several years (H. H. Wilcomb), an outbreak of *Tetranychus 6-maculatus* Riley in Ventura County (E. E. Smith) and the control of *Pantomorus godmani* (Crotch) by means of cryolite (A. M. Boyce).

Sailing from Puerto Rico on September 7, 1933, Mr. W. F. Jepson, of the Imperial Institute of Entomology, took with him, en route to Mauritius, about 150 giant toads, *Bufo marinus* L., about 750 female Scoliid wasps of *Elis xanthonotus* Rohwer and about 500 predaceous larvae of the "cucubano," an Elaterid beetle, *Pyrophorus luminosus* Illiger. These predators and parasites are being taken to Mauritius in an attempt to increase the natural control of the white grub, *Phytalus smithi* Arrow, an accidentally introduced pest originally coming from Barbados. It has been found that the Porto Rican Scoliid, *Elis xanthonotus*, will attack *Phytalus smithi* grubs in captivity, the larvae developing and forming cocoons apparently normal in every respect, and it is hoped that the females carried by Mr. Jepson will accept the new host when released in the field in Mauritius. The toad and the larval cucubano are not closely restricted in their choice of food, and the chances of their survival in a new but similar environment appear to be good.

On September 5th, Mr. Jepson addressed the most successful and largely attended meeting of the Entomological Society of Puerto Rico yet held. He spoke on the organization of economic entomology in the British Empire, and, as an example of how problems are handled, detailed his own experiences in the present project.

It will be of interest to all workers in biology and to nature students everywhere to learn that the Council of the Biological Society of Washington just recently has reissued all the various parts of its Proceedings formerly out of print, and can now supply a limited number of complete sets of its Proceedings, volumes 1 to 46, 1881 to 1933, inclusive, or can also supply whatever parts may be needed to complete partial sets now in the libraries of individuals or institutions. Among the items again available is the formerly very rare Volume 3, July 1, 1884 to February 6, 1886, now lacking from a considerable number of otherwise complete sets. This volume contains, pages 35 to 105, inclusive, the well known work by Dr. G. Brown Goode entitled "The Beginnings of Natural History in America," the continuous demand for which contributed to the speedy exhaustion of the original edition. Lists of desiderata or requests for information should be sent to the Society's Corresponding Secretary, J. S. Wade, U. S. Bureau of Entomology, Washington, D. C.

Mr. E. Graywood Smyth, entomologist for the W. R. Grace & Company sugar estates in South America, has recently returned to Hacienda Cartavio, Peru, from an extended vacation in the States. He visited New York, Chicago, various points in the Middle West and in California, and made a special study of the latest methods being utilized in the propagation of Trichogramma. Because of the benefits to plantation cane that have resulted from three years of mass breeding and liberation of Trichogramma conducted by him in Peru, the Hacienda Cartavio has recently multiplied its facilities for the production of the egg parasite by increasing the moth rearing houses (built on the Hinds-Spencer plan) from two to six units, and it is aimed to turn out over thirty million wasps during the coming season.

Horticultural Inspection Notes

The annual Japanese beetle quarantine conference will be held in Washington, D. C., on October 24, and a conference to discuss possible modifications in the foreign nursery stock quarantine will be held on the following day.

In Circular BPQ-354, the Bureau of Plant Quarantine has modified the conditions of entry of narcissus bulbs. Hereafter, instead of requiring the hot water treatment of all such bulbs, only the shipments found infested at the port of entry will be treated and the nature of the treatment will depend on the pest found.

Messrs. G. M. Bentley of Tennessee and R. W. Leiby of North Carolina attended the August 30 and 31 meetings of the Southern Nurserymens Association at Jacksonville Beach, Fla. Dr. Leiby gave an illustrated talk on the Japanese beetle. He also invited the association to meet in Asheville, N. C., next year and the invitation was accepted.

A modification of the Kansas quarantine relating to the European corn borer, excludes from the list of restricted articles celery, oat and rye straw, cosmos, zinnia and hollyhock, and excludes Ohio, Michigan, and Indiana from the regulated areas so far as the restrictions with reference to other floral and vegetable host plants are concerned. This modification became effective on July 1.

Mr. L. M. Ames of the Federal Bureaus of Plant Industry and Plant Quarantine has been engaged during the past two months in checking on nurseries which grow barberry and Mahonia plants. Under a Federal quarantine, rust-susceptible barberries are not permitted to be shipped to the principal grain-growing States, and barberry-growing nurseries are checked to see that only rust-resistant species are grown.

The American Phytopathological Society at its June meeting appointed a committee to discuss the biological basis of plant quarantines with a similar committee of entomologists. Dr. L. R. Jones, Madison, Wis., is chairman of the committee of phytopathologists, and Dr. W. C. O'Kane, Durham, N. H., chairman for the committee from the American Association of Economic Entomologists.

A quarantine relating to the two-generation strain of the European corn borer was placed by the Michigan State Commissioner of Agriculture on June 19, under which the host plants are required to be processed or certified when shipped from the New England States, New Jersey, New York, Pennsylvania, or Virginia. No restrictions are placed on beans, beets, rhubarb or young floral plants or cut flowers of gladiolus during the period from January 1 to June 1.

The administration of the State Crop Reporting Service in Arkansas and of the Pure Seed Law was transferred from the Department of Mines, Manufactures and Agriculture to the Plant Board by a recent act of the legislature. The transfer became effective March 1. By the same Act the administration of the Apiary Inspection Law was transferred from the Apiary Board to the Plant Board. The Board appointed J. V. Ormond, Apiary Inspector, without pay, no appropriation having been made by the Legislature.

At the request of the Eastern Plant Board, the Bureau of Plant Quarantine recently called a conference to discuss possible State quarantine action on the European pine shoot moth (*Rhyacionia buoliana*). This was held at New Haven, Conn., on September 19. During the conference there was a field trip to observe the damage this insect is causing in Scotch pine and red pine reforestation projects in Connecticut. Representatives of Connecticut, New York, Vermont, Massachusetts, and Penna., and of the United States Department of Agriculture were present. A committee to work out specific recommendations for the Eastern Plant Board was appointed.

The annual fall conference of the Federal gipsy moth inspectors was held at Greenfield, Mass., on September 18. In addition to the usual items under discussion, the new joint certification plan, under which Federal certificates covering the Japanese beetle and white pine blister rust quarantines as well as the gipsy moth regulations are issued to New England nurseries largely by the gipsy moth inspectors, was covered in detail.

The Federal Public Works Administration has allotted approximately the following amounts for insect and plant disease suppression: $2,000,000 for gipsy moth work in Pennsylvania and also between the Connecticut River and the "barrier zone" in Connecticut, Massachusetts and Vermont; $80,000 for scouting and eradication of the Dutch elm disease in New York and New Jersey; and $2,000,000 for white pine blister rust suppression. These funds are in addition to the assignment of certain men from the Civilian Conservation Corps to the same or similar projects.

On September 15, the Federal Department of Agriculture held a public hearing at which consideration was given to the advisability of issuing a special quarantine against the importation of elm trees and parts thereof on account of the Dutch elm disease. Elm nursery stock has not been imported for several years on account of this disease in Europe, and the principal subject of discussion at the hearing related to the importation of elm logs and "burls." A number of companies manufacturing veneer from such burls were represented, and possible methods of disinfecting the logs were discussed.

Regulations relating to the phony peach disease, applying to both intrastate and interstate shipments, were recently placed by the States of Tennessee and Oklahoma. Provision is made under the Tennessee quarantine (as revised effective September 1) for the acceptance under permit of shipments of the host plants when grown in a disease-free county or disease-free environs within a mile of the planting, and when determined by tree-to-tree inspection to be free from the peach root borer. The Oklahoma rule, adopted in July, provides for the acceptance of the host plants under any one of the same conditions. The regulated area as designated under the Tennessee quarantine covers 8 entire southern States including Florida and Texas; also 8 counties in Illinois, 6 in North Carolina and one each in Oklahoma and Missouri. The Oklahoma rule does not designate the infested areas but apparently applies to shipments from any State.

The number of trees infected with the Dutch elm disease in New Jersey and New York was reported by the Bureau of Plant Industry to have reached about 398 in New Jersey and 15 in New York by September 15. The center of the infection is in Essex County, N. J., with a few trees showing the disease as far west as Bound Brook and New Brunswick, N. J., and as far east as White Plains, Rye, Port Washington and Lynbrook, N. Y. Mr. R. Kent Beattie of that Bureau stated at the annual Shade Tree Conference held in New York City on September 8 that apparently the disease had entered this country on elm logs and "burls" from Europe, and was being disseminated by bark beetles. A number of such logs infected with *Graphium ulmi*, the causal organism, and infested with *Scolytus scolytus* have recently been intercepted at various ports and treated. The species apparently responsible for the spread of the disease in New Jersey and New York is said to be *S. multistriatus*, a European form which is established in this country over the area approximately from Boston to Philadelphia.

The Lower Rio Grande Valley of Texas suffered severely from the hurricane of September 4 and 5. From 90% to 95% of the citrus fruit is reported to have been blown from the trees. Mr. L. A. Strong, Chief of the Federal Bureau of Plant Quarantine, visited the area about September 14, to consult with Mr. P. A. Hoidale and the local growers as to methods of disposing of the fallen fruit to prevent Mexican fruit flies from reaching it and breeding there. Considerable damage was done to the railway car fumigation house operated by the Bureau at Brownsville, Texas. The roof of the house was blown clear away, the walls cracked and the large end doors were badly twisted out of shape. Records and supplies stored in a room adjoining the fumigation chambers were destroyed or badly damaged. Fortunately, none of the inspectors stationed at Brownsville and other lower valley ports suffered any personal injury, although the residence of one was badly damaged.

Changes in Washington State quarantines made in July include the following: (1) The Colorado potato beetle quarantine was revoked for the reasons, according to the notice, that the insect is now generally established in many localities in the State and that its presence in shipments of potatoes can be readily detected by inspection; (2) The territory involved under the cherry fruit fly quarantine is now extended to include Idaho with two counties designated as infested, while the number of *uninfested* counties in Oregon has been increased from 5 to 11. In Washington they number 21 and part of another; (3) The quarantine relating to the downy mildew of hops now includes as infected territory those counties in Washington west of the Cascades. The embargo now applies to intrastate movement and remains in effect as to shipments from Oregon and British Columbia into uninfected territory; (4) Provision was made under the potato tuber moth quarantine for the acceptance of certificates based either on inspection or fumigation. Formerly fumigation was the only condition of certification; (5) Quarantine No. 11 relating to the Oriental fruit moth, No. 17 relating to the strawberry root weevils and crown and cane gall of berry plants, and No. 18 relating to the European corn borer, were all reissued on July 11, apparently without modification, over the signature of the present Director of Agriculture, Walter J. Robinson.

Recent changes in California quarantines include the issuance, effective August 23, of Proclamation No. 3 pertaining to the Oriental fruit moth, which supersedes Quarantine Order No. 3. Under the new proclamation "provision has been made whereby budwood or scions of new varieties of the host fruits covered may be brought into California from the quarantined area under proper safeguards, thus permitting California growers to secure certain new desirable varieties of fruit trees which have recently been developed in the eastern United States." Missouri and Kansas have been added to the quarantined areas. Quarantine Proclamation No. 11, effective August 23, supersedes Quarantine Circular No. 1 and "is intended to cover the subject of peach diseases and includes little peach as well as peach rosette and peach yellows. The only change in the quarantine area from that shown in Quarantine Circular No. 1 is the addition of the State of Illinois, while the host list has been increased to now include apricot, almond and plum as well as peach and nectarine. This increase in both the quarantine area and in the host list has been based on advice received from the U. S. Bureau of Plant Industry." The California Bureau of Plant Quarantine has also issued a circular to County Agricultural Commissioners, regarding border quarantine inspection policy "in order that there may be uniform action in the disposition of plants and plant products passing through border stations so far as inspection by the County Agricultural Commissioner at destination is concerned."